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EVERYTHING PNEUMATIC.

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A WATERFALL FROM AN AIR LIFT.

AIR LIFT PUMPING

BY CHAS. A. HIRSCHBERG.

It is now some twenty odd years since Dr. Pohle advanced his theory of pumping water by compressed air and the first air lift plant was installed, and we have come to accept it as a matter of course, some of us scarcely realizing its real importance to thousands of municipalities, manufactories and private establishments, such as hotels, office buildings, etc. Let us consider for a moment the points of merit possessed by this system that have caused it to be so generally accepted and recognized as a desirable, efficient and simple means for not only pumping water, but as a semi-liquid transmitter.

There is no mystery connected with its operation; on the contrary, simplicity is the dominant feature, both as to installation and operation, while economy falls short of the proper

description when thought of in connection with attendance and maintenance. The man with a pumping problem, upon seeing the air lift in operation, wonders at the simplicity of the equipment, and the very numbers of its installations overwhelmingly attest its success.

As an eliminator of trouble and labor, it ranks high; in fact it heads the list of all pumping methods. Think of not having any pump to watch, distant and individual plant installations to make and take care of, no sinker rods to break and wear out and in-so-far as the well itself is concerned, no mechanical movement whatever to act as a constant source of annoyance and expense. This latter point in itself is of sufficient importance to recommend the use of an "Air Lift" in preference to other systems; it is a guarantee that it is no longer requisite to keep five or six men on the job to haul out from twenty to thirty connecting pieces and pipes for some irksome repair, while the water supply is crippled until the damage can be adjusted or repaired.

The Air Lift system is only limited by the capacity of a well to yield water. It will not only pump all the water which a well will deliver, but will increase its capacity with service owing to the cleaning action exerted. It carries off the sand and earth, permitting a more ready inflow of water, whereas with ordinary pumps the natural tendency is to clog the well, or, if sand and dirt are carried into the pump, to injure and impair the action of the pump itself.

The theory of the Air Lift has been expounded so often and is so well understood, that it is not the writer's purpose to go into a long dissertation on the subject. Summed up briefly, this system involves the use of an air compressor located at the most convenient point irrespective of the location of the wells; an air receiver adjacent to the compressor, a pipe line for conveying the air from the receiver to the wells, one or more wells drilled to a depth proportioned to the height of the lift and the depth of the water below the surface, air and water pipes running down inside of these wells, the proper proportion of their vertical length submerged when at work, representing the pumping apparatus proper.

USES FOR THE AIR LIFT.

City and town water-works, asylums and hospitals, plantations, railway water tanks, irrigation, private country houses, pumping mines, ice manufactories, breweries, cold storage and packing houses, textile mills, dye works, bleacheries, sewerage installations, dry docks, seaside water-works, stock farms, etc. In fact, anywhere and everywhere that clear and abundant water is needed.

In many cases private water companies and cities have installed water meters to measure the amount used by manufacturing concerns, and the cost of water has therefore risen to such a point as to become one of the considerable expenses to any manufacturing plant. The insurance companies have also placed restrictions on such establishments and have made demands which make it desirable to have an independent water supply.

In addition to its value for raising water, compressed air lends itself with especial facility to the difficulties involved in handling brine from salt walls, for raising acids, acid solutions, and other liquids of high specific gravity and corrosive character. In manufacturing establishments it is used extensively for ore leaching, handling dye, paper pulp and fluids. In sugar refineries, and places where gritty particles and chemical solutions have to be handled, the air lift is being employed.

There are no working or moving parts of any sort in contact with the liquid, and in consequence the few pipes and tanks necessary for storage and moving the liquid can be made of materials unaffected by the fluid. Even wooden pipes are sometimes used.

Recent inquiry tends to show that a greater percentage of municipal water works than ever before are resorting to the air lift system of pumping; such plants are being installed at the present time at the following points; Matawan, N. J., Jamaica, L. I., Fulton, Ill., Howard Park, Md., Prescott, Ariz., So. Orange, N. J., Minden, Nebr., Fond du Lac, Wis., Huntsville, Tex., etc.

The installations treated in the following are typical of any number of such plants dotting the country and it would seem upon an examination that the merit possessed by this system is deserving of even greater recognition than now accorded it.

AN AIR LIFT TEST.

An air lift test was recently made in Indiana which affords an opportunity for comparison between the efficiency of the Air Lift System of pumping and one of the best and most economical deep well pumps made.

This Indiana water-works for over a year used a second hand 16 and 18¼x18 inch

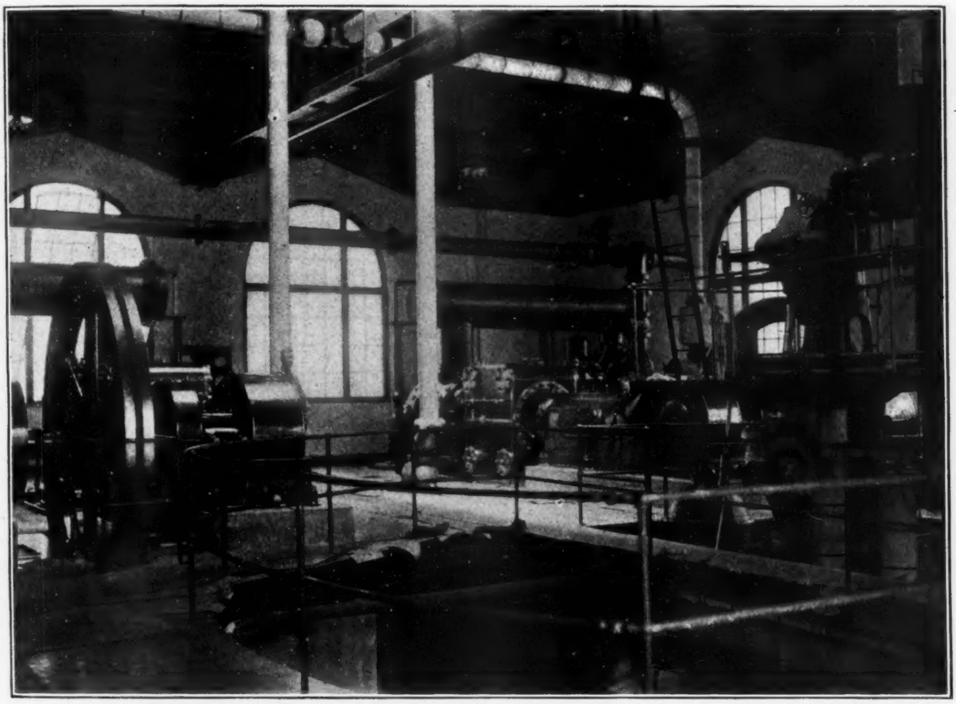
Class "A-1" Ingersoll-Rand compressor to operate an Air Lift furnishing a temporary water supply. Recently the pump company obtained permission to make a test and installed two of its belt-driven pumps with cranks and pitman, giving a double-acting effect with a definite length of stroke.

In this case the pumps were driven by an ordinary portable engine and boiler. The test was conducted by a well-known consulting engineer who was employed by the city to make tests to determine which system should be adopted. As a result of these tests, which were very thoroughly made, it was definitely shown that the deep well pump raised 60 gallons of water per pound of coal burned under the boiler while the Air Lift plant, under the same conditions, raised 300 gallons per pound of coal burned.

The test affords an idea of the relative efficiency under like conditions. Admitting a much higher efficiency for the pump in cases where economical engines are used, it should also be borne in mind that the efficiency of the air lift plant could have been increased by using Corliss compound compressors, and that a power driven deep well pump such as was used in this case is much much efficient than the more usual type, which is driven by a direct-connected steam head, so that the comparison would be about the same for average conditions.

SALT WELLS.

Brine of a profitable saturation is secured and the output greatly increased. Many such plants are using the air lift advantageously, special methods of piping avoid difficulties common to this class of well. An example of unusual interest is the salt wells of a large Lumber Company. These wells are 2017 feet deep the last 30 feet of which is solid rock salt. They are cased 8 inches down to 616 feet the balance being a 7-inch uncased hole. A 4½-inch pipe extends entirely to the bottom of the wells, which provides an annular space around its outside between it and the walls of the wells. Inside of this pipe is a 3-inch liquid discharge pipe extending down 985 feet. At the bottom the outer pipe has a reducer fitted to it, so that if the 3-inch pipe



COMPRESSOR ROOM PLAINFIELD UNION WATER COMPANY

should rust through and drop it would be caught and could be pulled up by the outer pipe.

The fresh water is run down outside of the 4½ inch pipe and kept up to within about 100 feet from the top of the well. It dissolves the rock salt at the bottom and is lifted up through the central 3-inch pipe, the air being forced down the annular space between the outside of the 3-inch and the inside of the 4½ inch pipes.

The compressor is a straight line machine, with steam cylinder 22 inches in diameter, and compound air cylinders 18¼ inches and 9 inches, all with a 24-inch stroke. They pump three wells at a time, and with the compressor running at moderate speed about 600 gallons of brine per minute is secured.

MUNICIPAL WATER PLANTS—PLAINFIELD UNION WATER COMPANY, PLAINFIELD, N. J.

Until two years ago the Plainfield Union Water Company, supplying the city of Plainfield, used the direct suction method in connection with a 140 ft. reservoir to obtain the effective head, but as the water level was getting dangerously low extensive investigations were made regarding the best method of obtaining an increased water supply and allow for a lift beyond the range of suction pumps.

They finally decided that the Air Lift system possessed peculiar advantages that would prove the most convenient and economical method, special consideration being given to simplicity and reliability. They accordingly installed a small steam driven compressor and invited three manufacturers to run competitive tests to determine the most efficient and desirable method of air lift for their purpose. The Ingersoll-Rand Company, using Harris foot pieces, developed the greatest efficiency upon the preliminary tests, and on the strength of this the water company purchased two Cross-Compound Condensing Compressors, type OC-3, 27 inch stroke, with steam cylinders 20 and 34 and air cylinders 32¼ and 21¼ and fitted twelve 7 inch and 10 inch wells with Harris foot pieces; the depth of these wells varies from 300 to 500 feet, with casing to the rock at 90 feet. The average length of discharge pipe is 210 feet and the lift is approximately 89 feet.

Upon completion of the installation of the permanent plant a test was conducted to determine the over all efficiency, and after a careful adjustment of the wells very favorable results were obtained. Three thousand, six hundred and six gallons of water per minute (3,606) was pumped from 8 wells. The lift in this test was 89½ lbs. and 1583 cu. ft. of free air per minute was used at a pressure of 60 lbs. This work represented 82.85 water horse power and the indicated horse power in the stream cylinder of the air compressor was 211, giving an over all efficiency of nearly 40 per cent. It should be borne in mind that but one compressor was used in this test. This is as good a result as has ever been obtained from any air lift system under similar conditions.

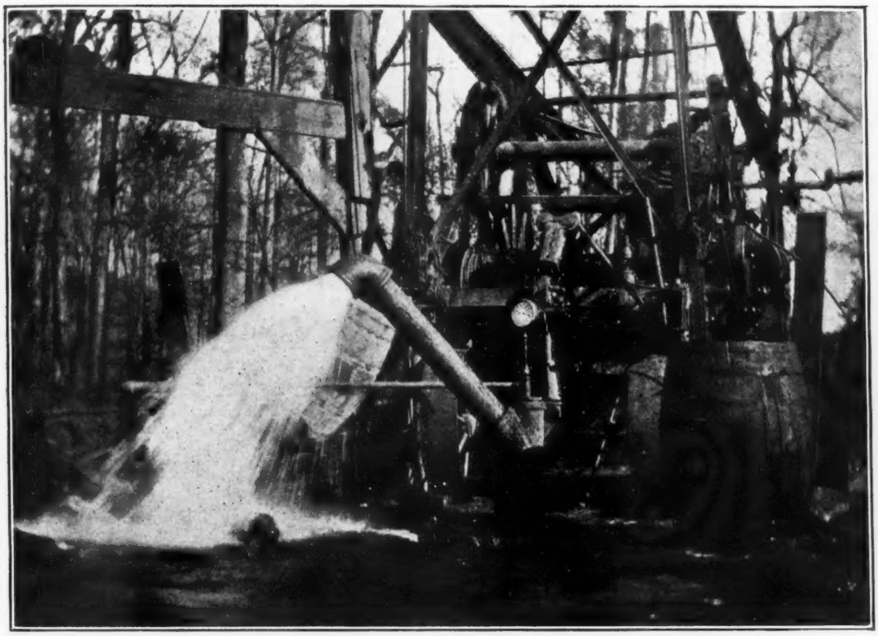
So far as the cost of operating this plant is concerned, it should be understood that this company is using steam pumps in conjunction with the air compressors, taking the water from the receiver on the ground and pumping it into a 140 foot stand pipe.

The Water Company was unable to determine just what the fuel consumption was of the air plant alone, but taking in conjunction with the steam pumps which were forcing the same volume of water against a head of 150 feet the entire plant was handling on an average day, approximately 5,700,000 gallons and consuming twelve tons of coal; taking $2.60 as a fair price per ton, this would give about .0055 cents per thousand gallons delivered to the mains. This plant has now been running continuously for about eighteen months and no trouble whatever has been experienced with it.

So far as the cost of such a plant is concerned, the statement of the Water Company which is quoted herewith is the best argument that can be offered on the question.

"The first cost of this plant was considerable, but we feel that by buying carefully as we did and entrusting ourselves to thoroughly reliable people it has paid us in the long run. I do not hesitate to recommend the air lift for municipal work and have always found it reliable and safe."

The compressors installed are of the Duplex Corliss Steam Driven type, with steam reservoir placed transversely below the floor. The air cylinders are equipped with an overhead intercooler and a large water separator or moisture trap on the discharge pipe through which all air passes after cooling. The main frames are of the enclosed type and provided with a flood lubrication system. Automatic control of speed and pressure, and regulation of output to load, is provided for. The inlet



AIR LIFT DISCHARGE, GRIFFIN, GA.

valves are of the "Hurricane Inlet" type with Cushioned Direct Lift Discharge valves. Cylinders are completely water jacketed on heads and barrel. The entire design embodies great accessibility, the value of which cannot be over-estimated, as convenience of supervision plays an important part in the economical operation of such a plant.

REPORT ON AIR LIFT PLANT, CITY OF GRIFFIN, GEORGIA.

Population of Griffin.............. 7,478
Number of water connections...... 575
Total average pumping per 24 hours. 200,000 gal.
Number of services metered....... 89%
Number of wells 4
Depths of wells.................. 500 ft. each
Diameter of wells:
No. 1 and 2—6½ inches top, 5 inches bottom.
No. 3 and 4—8 inches top, 6½ inches bottom.
Number of gallons pumped with compressor per minute..................... 500
Average number of hours wells are pumped per 24 hour day................. 7
Starting and working pressures:
No. 1 and 2.........150 lbs. start, 80 running
No. 3 .... 65 lbs. start, 45 running
No. 4 .... 85 lbs. start, 70 running
Speed of the compressor, 175 RPM.
Size of compressor, 14 and 9 x 12, "Imperial" Duplex Compound Belted.

System of piping for wells:
No. 1—Central Air Pipe System.
402 ft. of 4 inch discharge pipe.
365 ft. of 1¼ inch air pipe.
No. 2—Central Air Pipe System.
188 ft. of 4 inch. discharge pipe.
1 ft. of swedge nipple.
307 ft. of 3 inch discharge pipe.
495 ft. total length of discharge pipe.
307 ft. of 1¼ inch air pipe.
No. 3—Central Air Pipe System.
213 ft of 4¾ inch discharge pipe.
179 ft. of 1¼ inch air pipe.
No. 4—Harris Air Lift, with 3 inch pump.
201 ft. of 3 inch discharge pipe.
10 ft. of 3½ inch pipe on bottom of pump.
201 ft. of 1 inch air pipe.

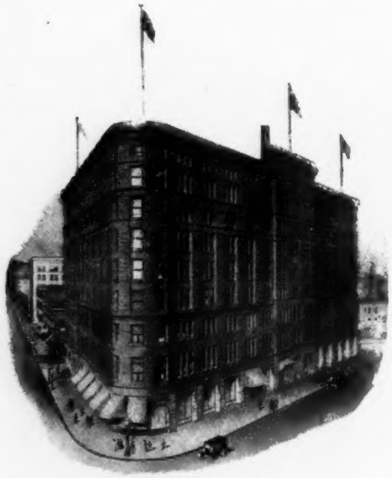
The water bearing stratum is a hard and medium granite formation.

Cost per thousand gallons distributed in the mains, 3¼ cents.

An analysis of the above figures shows that the total water pumped averages 270,000 gallons per day of 24 hours at a cost of $8.77, or 1 17/100 mills per person.

COLORADO AIR LIFT PLANTS.

Twenty-five years ago the city of Denver, Colo., had flowing artesian wells in abundance, but with its growing population and increasing water consumption the average water



BROWN PALACE HOTEL, DENVER.

level receded to more than 200 feet from the surface, gradually compelling private water plants to resort to some means of raising the water from the wells. Hotels, office buildings, department stores and factories, one after another installed Air Lift plants as a solution of the problem until to-day Denver and its vicinity is literally dotted with them.

A plant typical of many is located in one of the city's largest and oldest hotels, The Brown Palace. Here an unfailing supply of wholesome, aerated, artesian water, cool, clean and sparkling is furnished to all guest rooms as well as for general purposes, making the hotel entirely independent of city water supply, except for fire protection.

Water is pumped day and night from two 8 ⅝-inch driven wells located within the building. Each of these wells yields about 110 gallons of water per minute. The water stands approximately 220 feet from the surface, which is also the point of discharge. A starting air pressure of 130 pounds is required while the working pressure is 115 pounds. A duplex, steam driven compressor 12 and 18x16 and 10x14 of the Imperial type furnishes the air to a No. 7 Harris 20th Century pump, placed 510 feet from the surface with a submergence of 290 feet.

Another such plant is located at the Albany Hotel operated by a long belted-to-motor compressor, operating at less than half its rated speed, while a steam machine is held in reserve in case of breakdown in the electrical power line. This well yields probably more water than any of the wells working on the artesian underflow of Denver. The conditions of water level, submergence and air pressure are about the same in all Denver Air Lift plants with but few exceptions.

That this system of pumping water is well appreciated in "God's Country" is shown by the following more prominent list of such plants operating there:

The Mack Block, a large office building;

FIG. 1. PRUDENTIAL LIFE BUILDINGS, NEWARK, N. J.

the new Denver Gas and Electric Bldg., The Tabor Opera House Block, Clayton College, St. Thomas' Seminary, Denver Dry Goods Store, Colorado Ice and Cold Storage Co., Columbia Laundry, Equitable Office Building.

AIR LIFT FOR PUMPING DYES.

At the Hamilton Hosiery Mills, Chattanooga, Tenn., the Air Lift is put to a rather novel use; the transferring of dye liquor used in dyeing hosiery. The fluid is transferred from one iron tom-tom or kettle, holding about 55 gallons, to another of equal capacity.

These kettles drain into a barrel about 2 feet 6 inches deep, which is set flush with the floor. Through the bottom of the barrel a hole about 4 inches in diameter is bored and a pipe of this size carried down for about 8 feet. This gives the necessary submergence. The total lift from the bottom of the pipe to the discharge is 13 feet 6 inches. Each of the kettles is filled 15 to 17 times per day by this little lift, each operation requiring about 2½ minutes. The saving in dye liquor by this scheme amounts to about ¾ of a barrel per day, and this, together with the saving in manual labor forms quite an item in the day's work. The compressor is a small one of the Imperial Vertical Type. While this is not a new application of the Air Lift System, it shows its versatility. Tanneries use this system successfully for changing tanning liquids.

THE HOME OF THE PRUDENTIAL INSURANCE COMPANY OF AMERICA, NEWARK, N. J.

Fig. 1 shows the five buildings comprising the Home of the Prudential. It occupies most of the block bounded by, Broad, Academy, Bank and Halsey Sts., and is remarkable for the growth which has taken place during the past twenty years both in building area and in that of the power plant, in the former from a single building to 5 with a total area of 690,000 sq. feet and in the latter from 50 H.P. to 5000 H.P.

Upon entering the Power Plant, with which we are concerned (and more particularly the Refrigeration Plant) one is immediately impressed with the fact that here a master-mind has been at work, and that no pains have been spared to attain the acme of the engineers' art, so as to serve the Homes' numerous occupants efficiently and economically.

From the figures below one may gain an idea of the size and scope of this power plant.

Population of building, stationary	5,000
Population of building, floating	8,000
No. of buildings	5
No. of floors to the buildings	12
Floor area approximately	690,000 sq. feet

The population of a fairly good sized city is represented here.

Economy of the highest order prevails in the plant arrangement, type of equipment, attendance and supervision. Up to three years ago the water for house purposes and for general power plant uses, was purchased from the city, but owing to the ever increasing consumption and attendant cost, it was decided to drive several wells and install a pumping plant, provision to be made for a still further increase in consumption during the years to come.

Four wells were accordingly sunk, located as shown in Fig. 2, and after a careful consideration of the various pumping methods available, the wells were equipped with Air Lift pumps, the air for which is furnished at 75 lbs. pressure, by two steam engine-driven compressors, of the duplex Ingersoll-Rand type.

These compressors operate day and night at an average speed of 70 R. P. M., 300,000 gallons of water being pumped from 4 wells.

The following gives the daily scheme of performance:

Size of compressors—12 and 20 and 12¼ x 12.
Speed of compressors—70 R. P. M.
Starting pressure—100 pounds.
Working pressure—70 pounds.

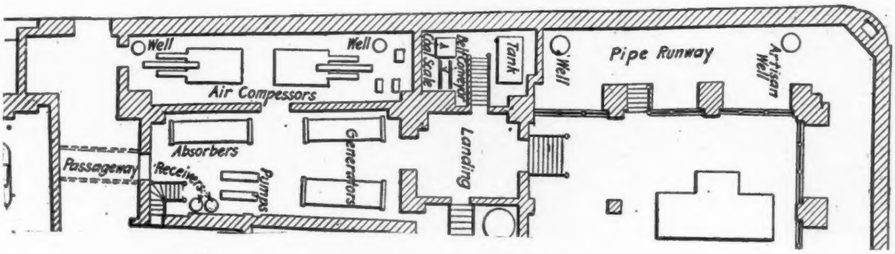


FIG. 2. LAYOUT OF WELLS.

Boiler pressure—150 pounds.
No. of wells—4.
Depths of wells—800 feet.
Piping in well—250 feet.
Size of wells—8 inches.
Submergence—150 feet.
Lift—108 feet to point of discharge.
Natural water level—80 feet.
No. of water taps—3,500.
Average pumping per 24 hours, 300,000 gals.

The method of piping the wells embodies a number of unique features. The foot pieces are of the Pohle Annular type, while the head pieces were designed especially to meet conditions imposed here. Exterior view of one well is shown in Fig. 3. Fig. 4 shows a cross section of this well. The head piece consists of a slotted pipe enclosed by a large separating pipe and which is capped and provided with a Tee to the discharge line.

The water is discharged from all wells into a central surge tank shown in Fig. 5, from whence it is pumped into a tank in the North Building and distributed into the mains throughout the building under a pressure of 80 lbs. due to natural head. On account of its constant low temperature this water is excellent for use in the condensers of the refrigeraion plant.

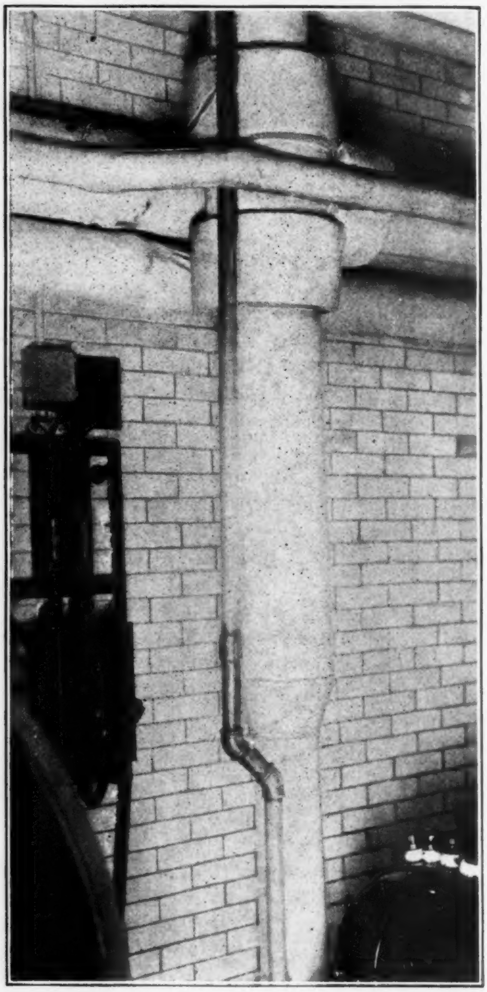


FIG. 3. ONE OF THE WELLS.

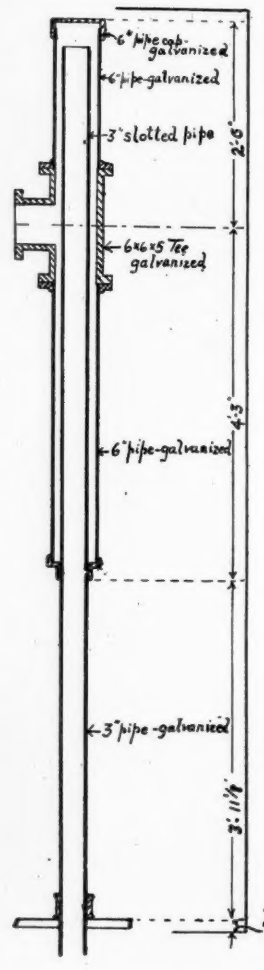


FIG. 4. SECTION OF WELL.

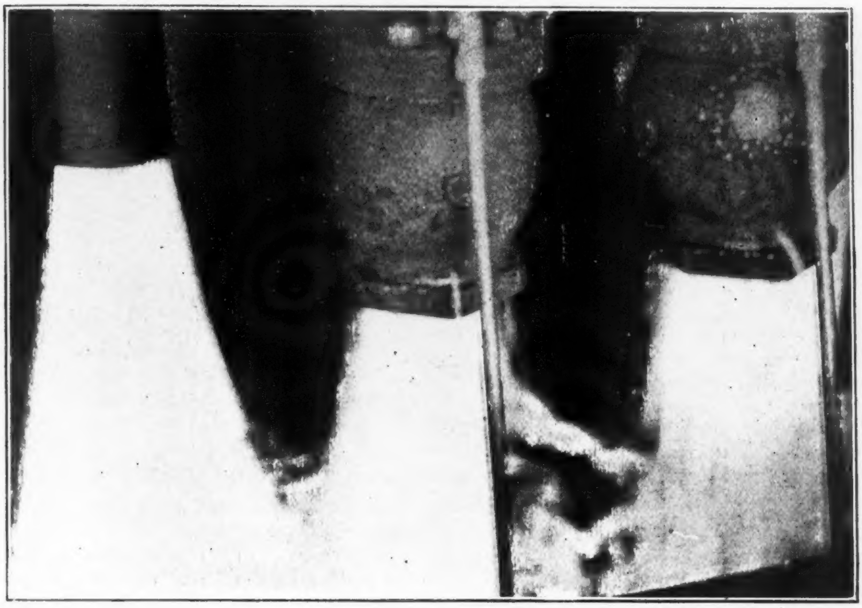


FIG. 5. THREE WELLS DELIVERING INTO TANK.

ACETYLENE DEVELOPMENTS

Consular Trade Reports give us some account of an exposition of acetylene apparatus recently held in Paris.

Among the numerous objects of interest were the so-called "light boxes." These require plunging in a pail of water when, by an ingenious mechanism contained in the box, the required amount of water automatically enters, and the gas generated is given off through tubing attached to the box and can be delivered any distance required. These boxes can thus be used at any moment and very economically to illuminate large open spaces, public fetes, etc. The boxes are useful for river and deep sea fishing. A floater is attached above the box, which is then immersed in the water.

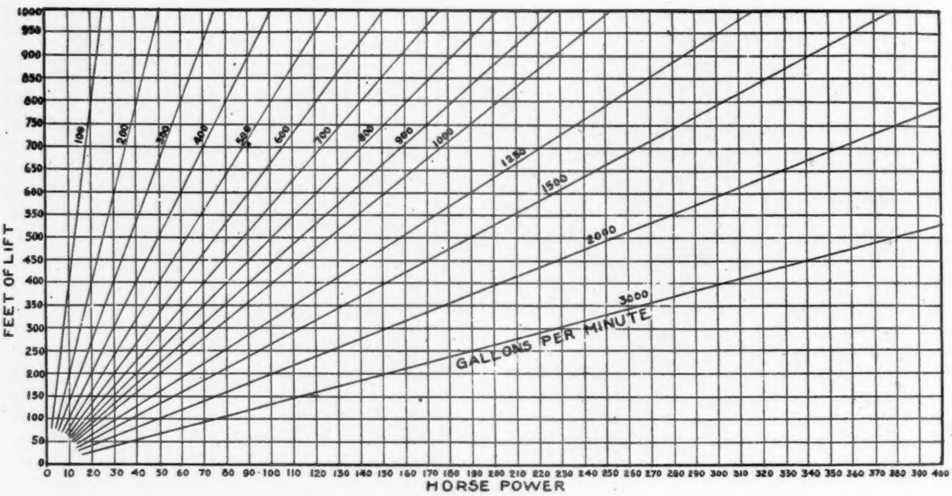
There was an exhibition by a firm which has undertaken large lighting contracts, including some 30 villages entirely lighted with acetylene.

The chief uses of acetylene, in which great progress is being made, are soldering, intensive generators for lighting construction works, works carried on by night, etc., mine lamps, hand lamps, insect-trap lamps for vines, etc., and automobile lamps, of which 700,000 are in use in the United States alone. It may be added that there are now 250 towns in France and Algeria lighted with acetylene.

In addition to its direct employment in the production of acetylene gas, calcium carbide is also used in the manufacture of cyanamid, a new outlet which offers almost unlimited possibilities of extension. Calcium carbide heated to a temperature of 1,000 degrees C. (1,832 degrees F.) absorbs a certain quantity of atmospheric nitrogen and changes into a new product, cyanamid, which has a chemical composition similar to that of guano and consequently has the same fertilizing qualities when employed in the same manner. When mixed with earth it is decomposed by the damp and yields both chalk and ammonia, which is oxidized into nitrates. Its efficacy is equal to that of sulphate of ammonia, of which the production for agricultural purposes exceeded 1,150,000 tons in 1911.

ONE OF THE SELF-STARTERS

The Pierce-Arrow automobile self-starter comprises an air pump on the forward end of the gear box, an air reservoir located horizontally above the muffler on the left side of the chassis, an air distributor on the motor which delivers the pressure to the cylinder in the firing position; a pressure gage on the dash and a control valve for bringing the air pump into operation whenever needed. There



THEORETICAL DIAGRAM OF POWER REQUIRED FOR LIFTING WATER.

is a jaw clutch mechanism between the air pump and the forward end of the countershaft in the gear box, by which the pump can be operated when desired through a control lever on the footboard.

The air from this pump is delivered into the tank where it is stored to a maximum pressure of 200 pounds. From this tank it is led to the air distributor, located on the left side of the motor, between the water pump and the lighting dynamo and driven by a continuation of the vertical oil pump shaft. From the air distributing housing, piping leads to special constructions in the cylinder heads, each of these containing a check valve. The control of the apparatus is from the floor boards, where there is also located a gage to show the air pressure in the tank.

The air distributor is a rotating disk, having a crescent-shaped slot. The air supply enters the cover of the distributor centrally and the air delivery pipes enter the distributor case beneath the disk. As the disk rotates its slot registers in firing order with the different cylinders delivering the air pressure to the one in correct position and to the other in sequence, so as to give a continuous turning movement to the crank shaft.

Air consumed in a blast-furnace, in making one ton of pig iron, amounts to 6 tons, while there are also used 4 tons of ore, coke, and limestone.

A WATER PUMPING DIAGRAM

BY FRANK RICHARDS.

The diagram here presented, which would seem to be entirely self explanatory, may be found convenient for ready reference in water pumping comparisons or in preliminary estimates of pumping requirements. It represents throughout the theoretical horsepower, or 100 per cent. efficiency, in pumping different numbers of gallons per minute to different heights, up to 1,000 feet.

The weight of the gallon being taken as 8.34 pounds the statement would be: Number of gallons per minute, multiplied by 8.34 pounds, multiplied by height of lift in feet, divided by 33,000 foot-pounds, equals horsepower.

Thus 500 gallons x 8.34 x 800 feet of lift ÷ 33,000 = 101 horsepower, as shown on the diagram.

It happens that the 500 ft. line is the highest horizontal line which is crossed by all the gallon "surves," and we may note upon that line that the horsepowers required for the different numbers of gallons raised to that height are as follows: 100 gallons, 12.6 horsepower; 200, 25.27; 300, 37.9; 400, 50.54; 500, 63.18; 600, 75.8; 700, 88.45; 800, 101.09; 900, 113.72; 1,000, 126.36; 1,250, 157.9; 1,500, 189.5, 2,000, 252.7; 3,000, 379.

CONSTANT PRESSURE AIR RECEIVERS

BY FRANK RICHARDS.

The following question has been brought to my notice with a request for an answer.

"If an air compressor has a capacity of 90 cu. ft. of free air per min., and delivers it at 90 lb. gage pressure, what volume does the compressed air occupy? My position is this: I have an air engine 3½x3½ in., which is to be run by an air compressor rated to deliver 90 cu. ft. of free air per min. at 90 lb. pressure and 250 r.p.m. The engine will run at 350 r.p.m. intermittently (about 3 min. with 6 min. rest), but the air compressor will be run continuously. What size reservoir would be necessary so that the pressure would not drop too suddenly? I would like to have the calculations on this, if possible. Also, how many cubic feet of free air does it require to give 1 cu.ft. of air at 90 lb. pressure?"

A. The question at the end of the above is covered by the one at the beginning, so that one answer will cover that part of it. It is generally better to call the normal atmospheric air pressure 14.5 lb. instead of 14.7 lb. as is customary, because we are generally enough above sea level to make this a better average. Then, if the air is compressed to

$$90 + 14.5 = 104.5 \textit{ lb.} \text{ absolute.}$$

the volume of 1 cu.ft., when compressed, will be

$$14.5 \div 104.5 = 0.1387 \textit{ cu. ft.}$$

It is not necessary to consider whether the air is compressed isothermally or adiabatically, or what may be its temperature when it leaves the compressor, as it will certainly lose all its heat before being used and then the above figures will apply .

The compressor is said to be rated at 90 cu. ft. of free air per min. This is taken to be the builders' rating based upon the full piston displacement. If all the inefficiencies are to be allowed for, there must be at least 20 per cent. deducted from the theoretical capacity, which would make the actual free air capacity 72 cu. ft. and the delivery capacity would be

$$72 \times 0.1387 = 9.98 \textit{ cu. ft.}$$

or, say, 10 cu. ft. per min. at 90 lb. pressure.

The air consumed by the engine at full pressure, 90 lb., and without cutoff will be

$$\frac{3.5^2 \times 0.7854 \times 3.5 \times 2 \times 350}{1728} = 13.64 \textit{ cu. ft.}$$

To this 25 per cent., at least, should be added to cover clearance and other losses, making the consumption 17.05 cu.ft. per min., at 90 lb., or

$$17.05 \div 0.1387 = 122.92 \textit{ cu.. ft.}$$

of free air per min.

As the compressor would run all the time, while the engine would run, according to the statement, only one-third of the time, the compressor delivery to supply the engine should be

$$122.92 \div 3 = 40.97 \textit{ cu. ft.}$$

of free air per min. instead of 72, and it would be necessary either to slow down the compressor or to blow off some of the air at the safety valve. If the compressor were slowed down from 250 to 150 r.p.m., the free air capacity per minute would be 250: 150: :72: 43. The 43 cu. ft. would be about right for the case as stated.

The receiver capacity would depend upon the amount of pressure drop that would be permitted, and the question does not tell this. Say that the air receiver has a capacity of 100 cu. ft., and is filled with air at 90 lb. pressure when the engine starts. The total contents would be

$$100 \div 0.1387 = 720.9 \textit{ cu. ft.}$$

of free air, say, 721. In three minutes' run of the compressor, it would put into the receiver

$$43 \times 3 = 129 \textit{ cu. ft.}$$

of free air, making the total

$$721 + 129 = 850 \textit{ cu. ft.}$$

In the run of three minutes, the engine would take out

$$122.9 \times 3 = 368.7 \textit{ cu. ft.}$$

of free air, and

$$850 - 368.7 = 481.3 \textit{ cu. ft.}$$

of free air, or its equivalent at a higher pressure, remaining in the receiver. Now

$$481.3 \div 100 = 4.81 \textit{ cu. ft.}$$

of free air to each cubic foot of receiver content, and 1: 4.81: :14.5 : 69.74. The pressure would be 69.74 lb. abs., or 55.24 lb. gage pressure, which would probably be a greater drop than the case would allow.

It is proper to remember that if the engine kept running at a uniform speed, taking out a constant volume of air for each revolution, the pressure drop in the receiver would not be as great as above computed on account of the gradual expansion of the air as the pressure was diminished, but it is evident that it would be enough to defeat the scheme of the installation, and a much larger receiver would be required.

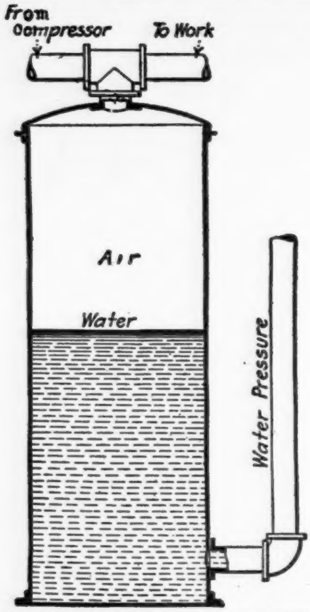
The outcome of the above question is just as unsatisfactory as it always is when dealing

with an air receiver as usually installed. There is no possibility of maintaining a uniform pressure in the receiver if there is any difference in the relative rates of compression and consumption, and as far as power storage service is concerned, the receiver might as well not be.

CONSTANT RECEIVER PRESSURE.

It happens that in most places there is water under pressure which may be piped to the receiver, city water service, water pumped to a tank on the roof or otherwise provided, and this water pressure may be employed to maintain the air pressure constant in the receiver, whether there is little or much air in it, so that the entire contents may be used at the full pressure, even if the compressor is stopped, or it may be used fast or slow within the limits of air supply with perfect satisfaction.

The arrangement is about as simple as anything in the world can be. As shown in the sketch there is a vertical air receiver and near



CONSTANT PRESSURE AIR RECEIVER.

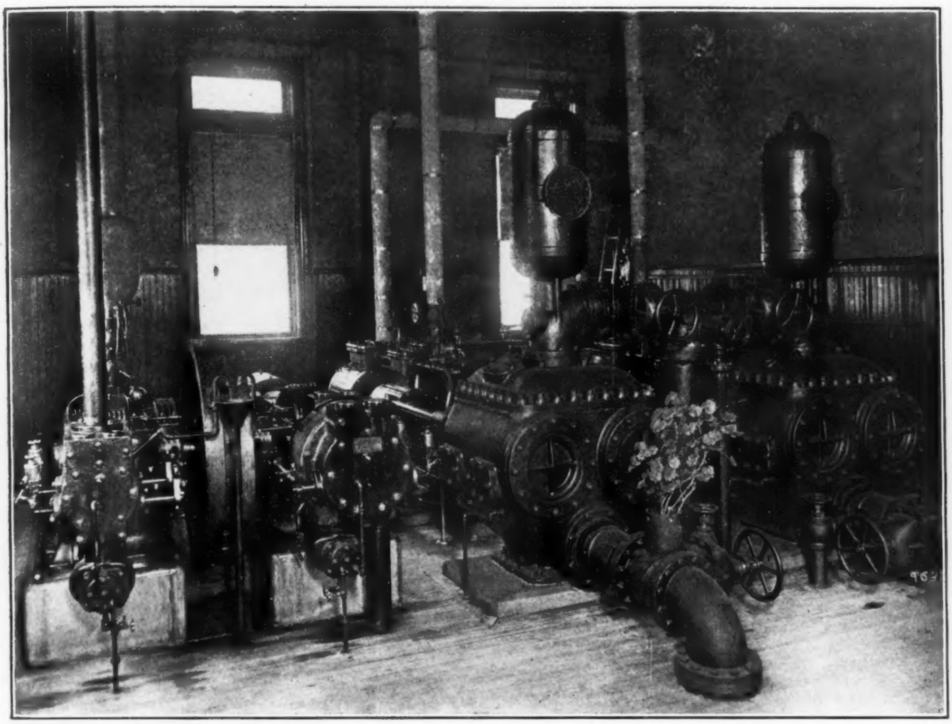
the bottom of it an open pipe connects the interior of the receiver with the water supply, so that the water pressure is always the pressure in the receiver. At the top of the receiver is an air pipe connecting the receiver with the compressor and the air being used is taken away from the same pipe which is in connection with the receiver. No valve or contraption of any kind is required, not even a safety valve, for the pressure can never exceed the constant water pressure.

If the compressor is delivering the air just as fast as it is being used none of it will go into the receiver at all but will pass right along to its work. If the compressor is delivering more air than is being used the excess of air will go into the receiver and drive the water down in the receiver and back to its tank or reservoir. If there is more air being used than the compressor is supplying, the water pressure will drive air from the receiver into the pipes to make up the deficiency; and this it will continue to do until the air is all out and the receiver is full of water. There is not even any waste or consumption of water, as none of it is carried off or escapes. It just plays back and forth between the receiver and the water tank or reservoir.

If there is a reliable water pressure obtainable and if it is not just the pressure desired, this can be varied by locating the receiver upstairs or downstairs, on the roof or in the cellar. Placing it 11 ft. higher will reduce the pressure 5 lb. and putting it 11 ft. lower will increase the pressure the same amount. With this arrangement so generally available, its employment should add much to the value of the air receiver in compressed-air practice. This device was employed in magnificent proportions by Bruno V. Nordberg for the reconstructed hoisting plant of the Anaconda Copper Co., located at Butte, Mont.—*Power.*

OXYGEN SAVED HIM

Ten tanks of exygen pumped through twenty tons of coal that buried him beneath their weight probably saved the life of Joseph E. Foster, a stoker at League Island. While at work at the navy yard he missed his footing and slipped into the chute, and was immediately plunged into the coal that was burying him alive. Fellow workmen saw him drop and ordered the coal shut off. William Riter, the chief marine hospital steward, ordered an inch pipe to be driven through the coal pile, and this was immediately attached to the compound oxygen tank and the fresh air pumped in, while the rescuers got busy with their shovels. It took exactly 65 minutes to reach the man, and when he was taken from the coal pockets he was unconscious. Artificial resusciation brought him around.



AIR COMPRESSOR AND STEAM PUMPS, WAUWATOSA, ILL.

CITY OF WAUWATOSA "AIR LIFT" PLANT

The city of Wauwatosa, a suburb of Milwaukee, Wisconsin, derives its water supply from an artesian well having a natural flow at the surface of about seventy-five gallons per minute. Previous to 1911 the water supply was pumped direct from the well into an elevated storage tank, but with the increasing demand the year 1910 found the city without an adequate supply and it was finally decided to secure the necessary increase by use of the "air lift" system of pumping, delivering the water from the well into a surface reservoir and re-pumping from this into the elevated tank.

In June, 1911, an Ingersoll-Rand "Imperial" air compressor, size 8 and 13 and 12 and 7½ x 10, was installed and the well piped for air lift, using a 6 in. water discharge, extending to the depth of 202 ft. 10 in. from surface, and a 1½ in. compressed air line extending to the depth of 190 ft. 9 in. Operating under the above conditions a gauge pressure of 82 pounds per square inch is required to start the flow, which pressure when pumping at the rate of 500 gallons per minute falls to 65 pounds. To deliver this amount of water the compressor runs 120 revolutions per minute, and six hours' pumping per day is sufficient to supply the city at the present time.

With the old system of pumping direct from the well into the elevated tank the coal consumption amounted to 10.8 pounds per 1,000 gallons, and with the air lift, taking our figures from the twelve months of 1912, the amount of coal required for the two operations of pumping the water from the well into the surface reservoir and then re-pumping into the tank was 13.43 pounds per 1,000 gallons, indicating a coal consumption of 2.63 pounds to deliver the water from the well into the storage reservoir, and as the cost of coal delivered at the plant was $3.25 per ton, this gives a fuel cost of $.00427 per 1,000 gallons of water pumped, which is certainly a very favorable showing for the "air lift" system.

A large underground river was recently pierced in driving a tunnel through the Cote d'Or Mountains in France and the workmen barely escaped with their lives.

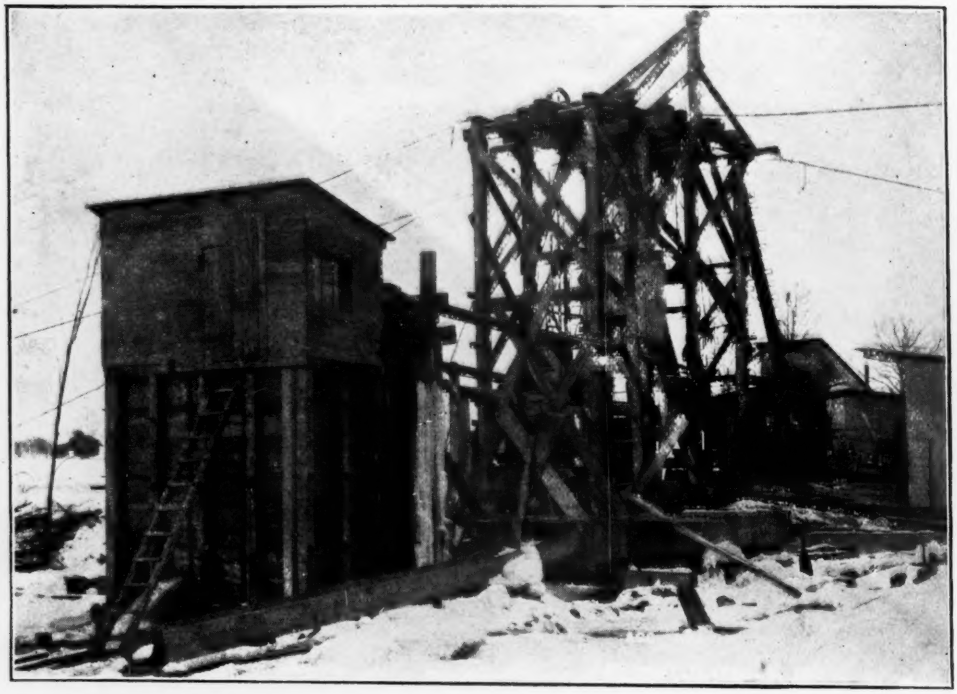


FIG. 1. HEAD HOUSE AND A CAMERON TANDEM SINKING PUMP.

HOW AN UNUSUAL SHAFT SINKING PROBLEM WAS OVERCOME

BY J. J. O'CONNELL.

One of the most difficult shaft sinking problems encountered in the construction of the Catskill Aqueduct was on the Rondout Siphon, extending from Storm King to Rondout.

From the bottom of the shaft on one side of the valley to the shaft on the opposite side is over four miles. This four mile tunnel, however, is not all of the same level, as a change was made near the middle to reduce the amount of difficult excavation. In all, eight shafts were sunk, varying in depth from 375 to 710 feet. No great difficulty was experienced in putting down any of these shafts except No. 4, which is 498 feet deep, and required eighteen months to complete, owing to the presence of large quantities of sulphurous water.

This No. 4 shaft is rectangular in shape, and measures 8x20 feet. It is divided into three compartments. About six weeks after the excavation began there was a sudden inrush of water through a bore hole, estimated at 600 or 800 gallons a minute, flooding the shaft to within 40 feet of the surface, but it was successfully pumped out to within a few feet of the bottom. To prevent a repetition of this the bore hole was filled with mortar.

After driving through a thick layer of limestone to a depth of 225 feet, the water came in so rapidly it was necessary to install two more pumps (No. 9 Cameron sinkers). A little later a stream came through one of the bore holes at the bottom of the shaft ,which caused the shaft to fill up to within 70 feet of the surface. Again it was pumped dry by the use of an air lift pump and two size 19 and 19x12x16 Cameron Vertical Plunger Sinking Pumps with tandem steam cylinders, located as shown in Fig. 1.

A 2-inch nipple, together with a gate valve, was used to plug the bore hole. The upward pressure of the water was found to be 75 pounds per square inch, indicating that there was a head of 173 feet. To ascertain where the sunken streams of water were, and what quantity of water might be expected, drilling was continued. Unfortunately, water was struck by two holes when one of the pumps was temporarily idle. The second pump was

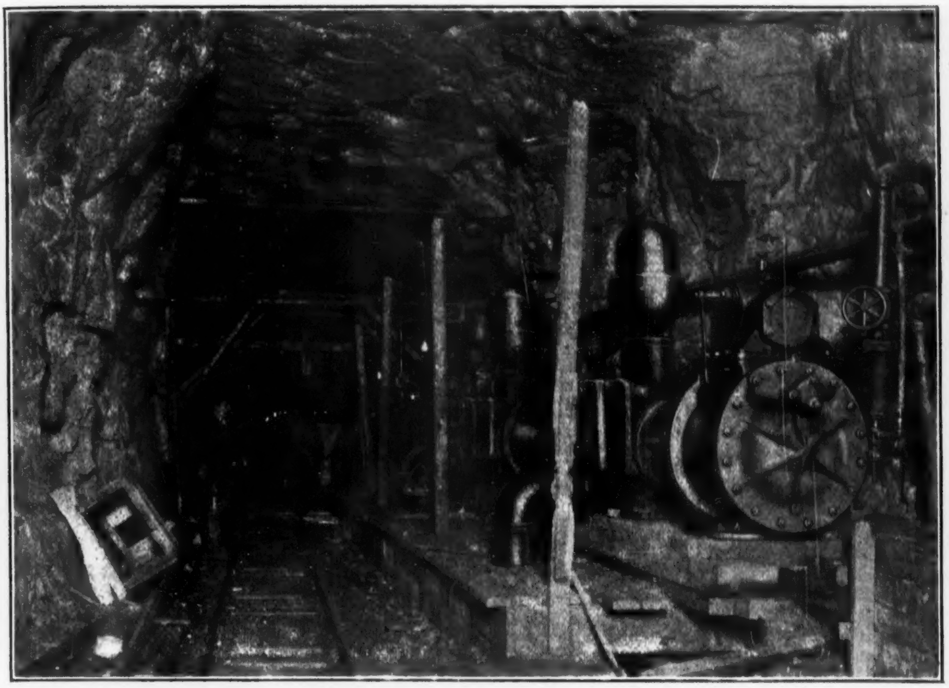


FIG. 2. BATTERY OF CAMERON PUMPS.

now called on for double duty, with the result that the discharge hose broke. The shaft was flooded and the pumps drowned. There was too much water to be handled by the pumping equipment available for prompt service. In fact the conditions were now so severe that in less than two weeks the shaft was flooded on two additional occasions. The bottom of the shaft was now at about the 260 foot level. Sufficient definite information was secured by the drillings, however, to show in some measure what was ahead of the contractor. The recent floodings of the shaft had occurred through 2 inch bore holes, and it was thought advisable to shut off the probable impending water.

It was decided to do this by the use of cement grout, and four grouting machines were installed at the top of the shaft. Difficulty was first experienced from the grout leaking back into the shaft through seams in the bottom and the joints around the pipes. This was overcome by injecting finely ground horse manure with the grout. Eventually the crevices were plugged. As a further precaution additional bore holes were put down; water under a head of nearly 150 feet was found at a depth of 14 feet below the bottom of the shaft, and the grouting process was repeated.

The bottom of the shaft was now in sandstone, but underneath the sandstone was 92 feet of a variety of shale, which it was feared would contain considerable water. To meet this possibility, six diamond drill holes were sunk, and at a depth of 50 feet below the bottom of the shaft water was struck, and when the holes passed the shale cement was injected. The pressure ran as high as 275 pounds per square inch, and 175 bags of cement were required to seal the seams encountered by the holes.

After a lapse of four months excavation was resumed. When a depth of 280 feet had been reached the amount of water coming in from the sides had increased to about 350 gallons per minute. A collection ring was put in at the 265-foot level and the pumps at the bottom of the shaft used this ring as a place of discharge. Two more Cameron Sinking Pumps, size 24x10x16, were used to lift the water from this point to the surface. At 289 feet the second ring was arranged, and a third at 306 feet. When the bottom of the shaft had been put down to 320 feet the conditions were very difficult. As the sinking continued the quantity of water increased, and more pumps were installed, until the shaft was crowded. It was

again flooded for the sixth and as it proved, the last time.

When the shaft had been cleared of water, a large pumping chamber was excavated off to one side at a level of 306 feet below the surface. This chamber was 10 feet high, and had a floor area of 17x24 feet. Beneath the floor a sump $5\frac{1}{2}$ feet deep was dug. This sump was large enough to contain 14,500 gallons of water. In this chamber were installed three Cameron Horizontal Piston Pumps, size 24x12x20, (as shown in Fig. 2), with a combined normal capacity of 1,200 gallons per mnute.

The amount of water pumped from this shaft No. 4 was estimated at 86,181,000,000 foot gallons, and 971 barrels of Portland cement were consumed in the grouting operations.

The work was done by the T. A. Gillespie Co., and the pumps were furnished by the A. S. Cameron Steam Pump Works of New York.

FILTERING AIR

Compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filteration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is pressed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

On the Witwatersrand 227 air compressors are in use with a total of 103,791 horsepower. Of dynamos, both direct and alternating current, there are on the Rand 232 with a total of 72,016 kw., and in all South African mines. 656 dynamos of 113,767 kw.

FIG. 1. 5 IN. CORES FROM 1,500 FT. HOLE.

CALYX CORE DRILLS FOR CAOL PROSPECTING

BY S. H. PAINTER.

The owners of coal lands who wish to thoroughly prospect their property before going to the expense of opening up mines by driving tunnels or sinking shafts, purchasing and installing machinery and mining equipment, naturally resort to the use of a core drill.

FIG. 2. COAL CORE FROM FIRST HOLE.

FIG. 3. SANDSTONE CORE—COAL CORE, IN BOX.

FIG. 4. DERRICK WITH STACK OF DRILLS.

In the earlier days of coal mining in this country, diamond core drills were generally employed, but in recent years the shot drill has come into prominent use. This change is largely due to the advanced cost of carbon for the diamond drill, which makes the work expensive, and necessitates—on account of the cost—the drilling of holes of small diameter, which naturally has a tendency to reduce the possibility of securing perfect cores of the coal vein; while the perfection to which the shot drill has been developed, renders it possible to drill holes sufficiently large to insure good records of the coal rapidly and inexpensively.

Actual information in the way of cost, drilling speed, etc., is often lacking when one not familiar with core drilling attempts to estimate the cost and time required to prove a property; therefore we give the following details of a case in Colorado that is typical of the average coal prospecting job:

The type of drill used was an Ingersoll-Rand Type "BF-1" Calyx, 1,500 feet capacity, equipped with a 38 foot sectional steel derrick, allowing 30 foot sections of rods to be pulled at a time, and 6 inch drilling tools giving cores 5 inch in diameter. Better progress could have been made if a 58 foot derrick had been used, allowing 50 feet of rods to be pulled at a time, as most all of the holes were deeper than 1,000 feet. The drilling plant was purchased by the Oak Hills Coal Co., who have headquarters in Denver, Colorado. The drilling was done on their extensive coal lands in Routt county, Colorado.

The Coal Company, before buying the drill, demanded that it should be guaranteed to drill

FIG. 5. 18 IN. CORES—WYOMING.

FIG. 6. CORE DROPPING OUT OF BARREL—AFRICA.

the first hole to a depth of 600 feet with 6 inch drilling tools at an average daily progress of not less than 9 feet per nine hour shift, and to produce good cores of the coal. Contrary to their usual custom, the Ingersoll-Rand Company after having one of their experienced drill men look the ground over, accepted the order on those terms. The following is a copy of the drill runner's report on the 600 feet guaranteed test:

RECORD OF BORE HOLE NO I, OAK HILL COAL CO., OAK CREEK, COL.

Type of Drill Used.	BF-1 Calyx.
Depth of hole	600 feet
Diameter of hole	6 inches
Diameter of core	5 inches
Number of 9 hour shifts	33
Greatest number of feet drilled in one shift	33
Least number of feet drilled in one shift	12
Average number of feet drilled per shift	18

Formation—Sandstone, slate, shale and limestone.

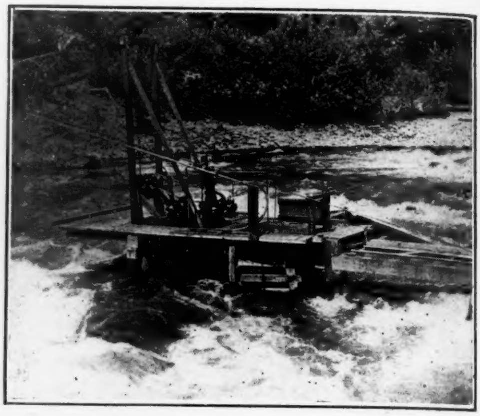


FIG. 7. DRILLING IN BED OF RIVER—OREGON.

Object of drilling—Coal prospecting.
(Three good working seams bored. 100 per cent. of 5 inch core obtained of each seam.)

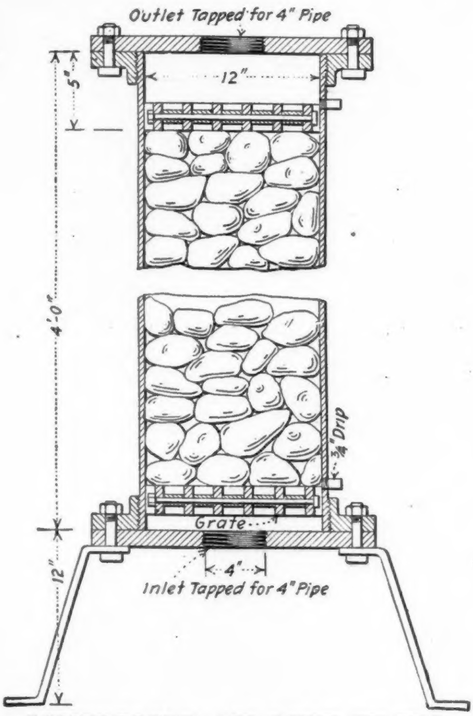
OPERATING COST.

Head driller per shift	$5 00
One helper	3 50
One helper	2 50
Chilled shot per shift	15
Shot bit per shift	20
Fuel (coal at $4.50 per ton)	1 50
Lubricating oil, etc	10
Total per shift	$12 95
Average cost per foot	.72

After the guarantee of the first 600 feet had

FIG. 8. DRILLING IN ALPES DE SAVOIE—FRANCE.

been complied with, the coal company continued the hole to a depth of 1250 feet, the progress being a little slower as the hole got deeper, due to the fact that more time was required to remove the core from the hole. A number of other holes have since been drilled ranging in depth from 800 feet to 1500 feet, and in all cases good progress, low operating cost, and splendid records of the coal drilled have been obtained.



COMPRESSED AIR DUST FILTER

BY W. G. HARRIS.

After setting up an air compressor in the vicinity of an ore reducing plant it was found that ore dust was drawn through the compressor into the pipe lines and finally into the pneumatic tools, causing trouble and expense.

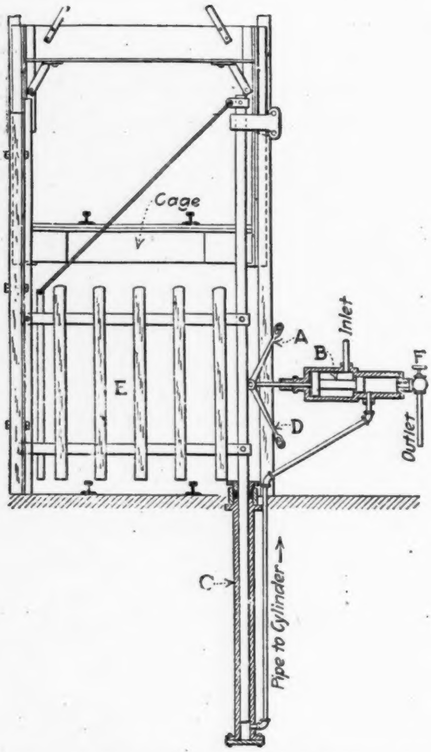
After considerable experimenting with various types of screens the following was adopted: A piece of 12-in. pipe, about 4 ft. long, was fitted with cast-iron screwed flanges on both ends. A cast-iron plate, tapped for a 4-in. pipe was bolted to the lower end, also four wrought-iron supporting legs.

A rought grate, made up of strips of 2x¼-in. flat iron with ¾-in. pipe separators 1½ in. long, and held together with one ½-in. bolt 11¼ in. long, was placed on the bottom. The pipe was filled to within 5 in. of the top with stones about the size of a large orange. The stones were dipped in a thick, sticky refuse oil, which happened to be handy at the time, before they were placed in the pipe. As we figured that in time the oil would work to the bottom, a second grate, similar to the other, was placed on top of the stones so the apparatus could be turned over and used in a reversed position. A flange and gasket similar to that on the bottom was placed on the upper end. Drip cocks were also placed near each end so that any accumulated water might be removed. The line from the compressor was then connected to the bottom flange, by nipples, ells and flanged unions; the same arrangement was used on the upper end to convey the filtered air to the machines.

Since installing this device two years ago we have cleaned it twice, and on each occasion found that a large amount of dirt, lint, etc., had been collected by the oil, without any reduction in the efficiency of the oil. This same arrangement can be used on the discharge end of all lines if they are of any great length, as all wrought-iron pipe will shed loose scale, especially when first put in service, also after being out of use for some time.—*Power*

A PNEUMATIC POLEAXE FOR THE SLAUGHTER HOUSE

A Poleaxe two and a half inches long, more efficient in cattle slaughtering than its primitive antecedent, is occupying the attention of London butchers. The weapon employed is the council "air-killer." In appearance it looks like a large sky rocket; the rocket end is a chamber charged with compressed air, the stick an elongated valve terminating in a poleaxe only some two and a half inches long. On pressing a trigger the poleaxe is thrown out against the head of the animal, the skull of which it penetrates easily. The animal falls instantly, showing hardly a trace of the hole thus pierced. The "air-killer" has just been adopted by the council as the result of an offer of a £100 prize. It was used upon sheep, calves and bullocks, all of which were, with one exception, killed instantly. It was clear that the efficacy of the instrument depends upon the operator's knowledge of the vital spot in the animal's skull.



AN AUTOMATIC SAFETY MINE GATE

An automatic safety mine gate has recently been invented and patented by M. W. Harvey, of Sykesville, Penn., which, due to its simplicity and ease of manufacture, requires more than a casual notice. It consists of a cylinder approximately 6½ ft. long made of 4½ in. pipe and provided with a stuffing box at the top, inside of which works a plunger made of 4-in. pipe which has been turned down and polished to a diameter of 4⅜ in. outside.

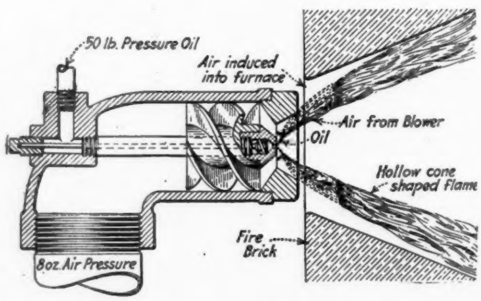
The cylinder is placed vertically in the ground, which renders it frostproof. It may be set at either side of the gate to be operated as convenience may dictate. The gate itself may be made by bending two pieces of strap iron and bolting wood palings vertically between them.

A controlling valve, somewhat similar in principle to a piston valve on a steam engine, is provided. This is equipped with a contact for the cage in its proper position for loading. The outlet, or exhaust, is provided with a throttle valve to control the downward movement of the gate. The general arrangement can be clearly seen in the accompanying drawing.

The operation is as follows: When the cage is brought to position for loading from the ground, it makes contact with the lever *A*, which operates the piston valve *B*. This admits air or steam to the vertical cylinder *C*, forcing up the plunger *D* and with it the gate *E*. When the cage is moved from this position, the piston valve *B* is forced back to its original place by the pressure of the air. This releases the exhaust and allows the plunger and gate to descend. The rapidity of this descent may be controlled by the valve *F* to any desired speed.

In the ordinary operation of hoisting, the contact between the cage and the lever *A* is only momentary while the cage is passing that point. Consequently, the amount of air admitted to the main cylinder is not enough to start the plunger from its initial position, and the gate therefore remains stationary.

This gate can be easily arranged so that temporary removal of one of the guides on the opposite side from the plunger will allow it to be swung open for the loading of long rails or other material upon the cage.



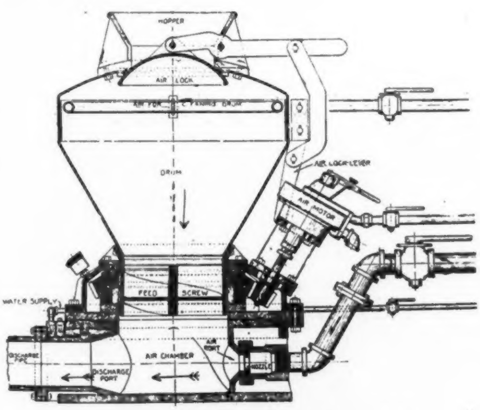
LOW PRESSURE AIR FOR ATOMIZING FUEL OIL

We here reproduce from Engineering News a sketch showing the essential features of a fuel-oil burner designed and recently patented by Mr. H. B. Stilz, 1938 N. Marvim St., Philadelphia.

A characteristic of many low-pressure oil burners has been their ineffective atomization of the oil and a consequent low combustion efficiency. Therefore recourse has usually been made to high-pressure air or steam for atomizing; but the general difficulty which seems to have been encountered here lies in the difficulty of thorough mixture of the oil particles with the proper amount of air, on account of the high velocity of the former.

This design shown comprises an inner nozzle through which oil is forced at 50 lb. pressure. At the end of the passageway in this nozzle is a small orifice and within the passage is placed a spindle bearing a spiral fin, which is claimed to cause the oil on delivery to rotate and spread out in a cone-shaped film. Around the inner nozzle above mentioned is a casing through which air passes, and within this casing is a larger spindle also with a spiral fin, which it is claimed gives the air a whirling motion as it passes out. By the velocity of the air in a radial direction from the burner axis, a certain amount of suction seems to be produced which draws the oil particles into the current of air. This, it is claimed, results in the desired intimate mixture and atomization. The shape of the issuing flame is controlled by the shape of the bell mouth of the outer orifice.

It is reported that competitive tests, conducted in 1912, at the plant of the Link Belt Co. in Nicetown, Pa., showed that this type of burner required only some 31 per cent. of the amount of fuel of high-pressure burners in use. Sizes have been made to give a capacity range of from under 1 gal. of oil per hour to over 400.



PNEUMATIC CONVEYOR FOR CONCRETE

The concrete "blower" as it is called, shown in the accompanying illustration, consists of a hopper and drum super-imposed over an air chamber through which a current of air is passed. The dry materials, mixed or unmixed, are placed in the receiving hopper, and, when ready, dropped as a batch into the drum by opening the dome-shaped air lock. The bottom of the drum is a flat feed screw, or worm, revolved by an air motor. This controls the rate and amount of concrete material fed. As the screw or worm revolves, it feeds the aggregates into the rapidly moving stream of air. Water is fed into the chamber at the same time. The idea in this machine is to take advantage of the velocity of the air to sweep along the material and not use it in any way as a pusher.

The conveyor described is manufactured by the Concrete Blower Co., New York City, and, the manufacturers state, should replace hoisting engines, buckets, elevator towers, cars and tracks. The economy of such equipment is especially marked in tunnel construction.

The amount of air required depends on the height and distance to which concrete must be handled. It is planned to build the blowers in five sizes, capacities running from 4 cu. ft. to 40 cu. ft. The manufacturers' specifications state that a pneumatic concrete blower outfit, suitable for placing 100 cu. yds. of concrete in 8 hours, a distance of 500 ft. from the blower, would consist of a blower of 10 cu. ft. capacity; 500 ft. of 6 in. pipe; necessary bends on a 5 ft. radius; an air compressor with a capacity of 500 cu. ft. of free air per min. at 60 lb. pressure, and an air receiver of 200 cu. ft. capacity. With a plant of this description 100 cu. yds. of concrete can be mixed and conveyed a distance of 500 ft. in 8 hours. The labor required to operate this plant, exclusive of the compressor, should consist of four men. —*Cement Age.*

HEIGHTS AND DEPTHS

Mount Whitney, the highest point in the United States, is 14,501 feet above sea level, and a point in Death Valley is 276 feet below sea level. These two points, both in California, are less than 90 miles apart. Mount Everest in Asia rises 29,002 feet above sea level, whereas the shores of the Dead Sea are 1,290 feet below sea level, a total difference in land heights of 30,292.

The greatest ocean depth yet found is 32,088 feet, at a point about 40 miles north of the island of Mindanao in the Philippine Islands. The ocean bottom at this point is, therefore, more than 11½ miles lower than the summit of Mount Everest, and the pressure at that depth is about 15,000 pounds to the square inch.

AIR LIFTS DISPLACE CENTRIFUGAL PUMPS

BY W. B. RHODES*.

In February, 1910, a new all-sliming milling plant, on the property of the Compania Minera Jesus Maria y Anexas, at Jan Jose de Gracia, Sinaloa, Mexico, was put into operation. There were installed for the purpose of lifting the tube mill discharges and final all-slime product, centrifugal pumps of a well known make. After six months' running it was found out that this type of pump was absolutely unfitted for this kind of work. Pumps were taken out after a run of 24 hours, others ran a week or two, others for a month. In all cases the shafts and liners were worn in such a manner as to suggest the presence of a mineral similar to emery.

The ore is very deceptive and this is shown by the fact that after passing 20-mesh screens in the batteries, a screen test will show from 48 to 50 per cent. through 200 mesh and 60 per cent. through 150 mesh. The remainder is composed of granules of quartz of a very compact nature. This product was that which caused the final removal of centrifugal pumps and the substitution of air-lifts. Shortly after my arrival here in 1910, I had suggested the immediate substitution of the air-lifts. No serious thought was given the matter, however, until the cost of maintenance, together with the loss of time due to shutting down the mill, not only on account of the sudden wreck of one or two centrifugal pumps, but also on account of rain being blown into the building, which caused the pump belts to fly off.

In October, 1910, the management seeing the folly of continuing with centrifugal pumps, broached the air-lift question to me, and requested that a design to cover the problem be made as quickly as possible. Accordingly two lifts were designed. One was a 2½-inch lift with 65 per cent. submergence, lifting the tube discharge an effective distance of 18 feet. The other lift was a 3½-inch with 54 per cent. submergence, and having an effective lift to discharge launder, of 38 feet. It took about two months to install the air-lifts, as pipes had to be ordered from the United States. It was thought best to have the well-pipes of generous dimensions, and accordingly, a 3½-inch well-pipe was placed in the lower or tube mill discharge air-lift. In the larger air-lift was placed a 4-inch well-pipe, thus eliminating any unnecessary friction. These pumps to date have been looked at but once since their installation in December, 1910, and the repairs have consisted of two nozzles and an 8-foot length of 2½-inch pipe for the two lifts. The lower or sand air-lift, has plugged up at times, but by closing the inlet or outlet and turning on high pressure air, the obstruction has been easily removed.

The original air pressure as figured was 25 pounds per square inch, but until automatic valves were put in, better results were had at 28 pounds per square inch. The total cost of the new installation, including the sinking of a shaft 5 feet square by 40 feet in depth, pipes, trestles and launders, did not amount to $300 United States currency. The saving may be summed up as follows:

Maintenance on centrifugal pumps, including cost of pumps, liners, shafts and mechanics' wages, per month	$200 00
Saving of 20 per cent. in H. P., or 5 H. P., at $1.25 per 24 hours for 30 days	187 50
Saving of 12 hours shutting down per month, equivalent to 40 tons of ore at $25	1,000 00
Total monthly saving	1,387 50
Total yearly saving	16,650 00

These two air-lifts have been working steadily without interruption for two years and have to their credit at least $30,000 U. S. currency. Nothing so far has been said about the compressor and its repairs, but as the former was on the property and idle, it has not been charged against the air-lift installation except as to its actual installation in the new power house, and which would not exceed $150 U. S. currency. The consumption of air varies from 2½ to 3 cubic feet for each cubic foot of sand or slime lifted, depending on the dilution of the pulp. For the final lift of 38 feet a minimum dilution of 5 to 1 is necessary to give good results. The lower or 18-foot sand lift is run on a 3 to 1 dilution to avoid excessive handling of solution.

In conclusion, I wish to say that the difference between smooth running by means of air-lifts and that of having to get out in the middle of the night to repair a broken down

*Superintendent Milling Plant, Cia. Minera Jesus Minera y Anexas, S. A., San Jose de Gracia, Sinaloa, Mexico. From the Colorado School of Mines Magazine, January, 1913.

centrifugal pump, is appreciated here as elsewhere, where others have had similar experiences.

GREATER PURITY OF DEEP-WELL WATER

During the last six years Dr. H. E. Barnard, Chemist of the Indiana State Board of Health, has analyzed about 5,000 well waters. The following we take from a paper by him before the Indiana Sanitary and Water Supply Association.

I am convinced, he says, that of the 2,000,000 wells furnishing water to the citizens of Indiana, at least 1,000,000 are not furnishing pure water, but a water contaminated by the wastes of the home and community. Of 4,959 wells examined in the last few years, 3,051 have been classified as shallow wells, and 1,908 as deep wells. This classification is not perfect, for it is frequently impossible to get data sufficiently adequate to place a well in its proper class. We classify all dug wells as shallow wells, and all driven wells as shallow wells when it is evident that the well does not pass through an impervious stratum. In some parts of the State a layer of clay or hard pan may lie so close to the surface that a driven well not more than 10 ft. deep may, in fact, reach second water, and so entitle it to be classed as a deep well.

In other parts of the State, especially where sand and gravel deposits are deep, a well may be 75 or 100 ft. in depth and still tap only surface water. Obviously, when we do not know all the facts, our classification is subject to some inaccuracies. Nevertheless, it is significant that of the 3,057 shallow wells used as private supplies, but 1,331 were good; that 1,391 were classified as bad and 335 as doubtful. Since a doubtful well water is bound sooner or later to pass the danger line, in the interests of safety it should be viewed with suspicion, and classed with the bad waters. This means that only 43.5 per cent. of the shallow wells are pure. Of the 1,377 deep wells used as private water supplies, 1,091 furnished pure water, 160 bad water and 126 doubtful water. In other words, more than 79 per cent. of all the deep wells furnish a pure water. The difference in the quality of the deep and shallow well is thus strikingly shown. If the actual facts were at hand, I have no doubt but that the proportion of deep wells of satisfactory character would be greatly increased.

There is no real reason why every properly cased well which passes through an impervious stratum should not furnish pure water, save in the isolated instances where sewage is poured through sink holes or abandoned gas wells into the lower levels. Such conditions do obtain in the cavernous regions in the southern part of the State, and they are not unknown in the so-called gas belt.

Is the time not soon to come in Indiana when the health officer, knowing as he does, that more than 50 per cent. of the surface wells are polluted, will take definite, positive and final steps toward closing them and compelling the community to use the public water supply of guaranteed purity? We are legislating for sanitary school houses where our children are gathered for months of the year. We are going farther than that, we are requiring by law that there shall be no unventilated and unlighted rooms. Is not the next step legislation which will prevent the unwise citizen from quenching his thirst by the effluents of his backyard?

The medical staff of our army recognizes the danger of the well. When a regiment recently made its march from Fort Benjamin Harrison to French Lick, Indiana, and back, the soldiers were under strict orders not to drink from any well along the road. That was official recognition of the danger of the well, and apparently the situation was in the hands of those who could control it. I believe the health officers of our communities have just as great powers as do the officers of the medical corps, if they would only use the courage of their convictions. If it were possible I should say to every health officer in the State, close every surface well in your community. If that is not possible at the present time because a pure public supply is not available, determine by examination at least once each year that every well is potable, and whenever a report is made to you that the water is receiving sewage effluent, close the well. At the time of examination it may still be potable, the solid content may be increasing, the nitrates may be high, but the evidence showing present pollution may be wanting. Remember, however, that any heavy rain may absolutely upset the conditions which have kept the water potable and flush into the well not only the filth from the surface, but debris accumulated in the earth.

WORK DONE BY CALYX CORE DRILLS ON ESTACADA HYDRO-ELECTRIC DEVELOPMENT, RIVER MILL DAM

The growth of the city of Portland and its suburbs has been so rapid, and the demand for light, power and additional railway facilities has increased at such a rate, that the Portland Railway, Light and Power Company have been obliged to augment their sources of power in order to keep in line with the public service demands. The Clackamas Canyon at River Mill, about 32 miles from Portland, is the site of a new power development—a late project of the company—which is said to have cost in the neighborhood of $1,000,000. We print here extracts from the final report of Frank R. Fisher, engineer in charge, on the grouting of the foundation for the cutoff, with special reference to the use of Calyx Drills.

CHARACTER OF FOUNDATIONS.

The characteristics of the underlying rock were investigated by means of core drilling, pressure testing, and surface examinations of exposed bluffs. In addition, a general knowledge was obtained by observing the material exposed by the excavation for the cut-off and the notch through the island, and also the deep gorge that was disclosed when excavating for the buttress foundations in the right channel. The gorge extending to a depth of forty feet below the bed of the river, offered an excellent opportunity for investigating the character of the rock existing at that depth.

The rock underlying the dam is of volcanic origin, and occurs mainly in the form of lava and ash conglomerate, with embedded boulders and fragments of hard rock of the nature of basalt, varying in size from small particles up to blocks with a principal dimension of several feet. Occurring in the conglomerate mass are isolated pockets, and layers of various other formations, including the so called soapstone, and a certain kind of brittle clay rock, very much seamed, with the joint faces in almost perfect contact. The latter material would permit the seepage of water under sufficient pressure, but would resist the diffusion of grout, and be but slightly benefitted thereby. Its occurrence, however, is so limited in extent, that no apprehension is felt from its presence.

The same may be said of the other heterogeneous materials distributed throughout the conglomerate mass, and it is principally the latter that had to be considered from the standpoint of stability and permeability, in investigating the foundations for the dam.

The rock mass is traced throughout with seams, very irregular in shape and size, extending in all directions with but slight continuity. They vary from an almost imperceptible cleavage joint up to those having an approximate width of from one to two inches, the large majority observed, measuring but a fraction of an inch. The seams are more or less choked with sand, gravel, small particles of rock, and other debris. No large crevices or faults were found at the site, nor observed in the vicinity of the dam.

On the whole, the rock gives indication of possessing fair bearing value, and while not what would be classed as hard, would probably offer considerable resistance to the erosive action of water, except under high velocities.

ARRANGEMENT OF GROUT HOLES.

On account of the permeable character of the foundations, due to the seamy condition of the rock, as disclosed by the preliminary investigations, it was deemed advisable to grout the foundations, the idea being to accomplish by this method a continuous curtain or cut-off, for a depth of 50 feet under the heel of the dam, across the canyon, and extending up and over the banks, for some distance on either side.

Many experimental tests were made in order to determine the most effective arrangement and spacing of the holes, through which the grout was to be introduced and diffused under pressure. The plan finally adopted contemplated three rows of holes under the heel of the dam, and parallel with the axis thereof. The two outer rows, located six feet apart, were termed the primary lines, and the spacing of the holes thereon was tentatively fixed at six feet. The third line located intermediate between the other two, and called the proving row, was put down after the grouting of the primary holes for the purpose of testing the effect of the grout as regards the tightening of the foundation material. The tentative spacing of the proving holes was also fixed at six feet, staggering with the primaries.

While this layout was generally adhered to throughout the operation, it was found necessary in certain localities to introduce additional

FIG. 1. PANORAMIC VIEW OF DAM UNDER CONSTRUCTION.

holes, when the water pressure tests on the proving holes indicated that further treatment was required. On a portion of the left channel section, where difficulty was experienced in tightening the foundations the final spacing became three feet on the primary rows and two feet on the proving line. Again, on the right channel and up the right bank, a number of holes called for by the tentative layout were omitted, where the pressure tests showed but little seepage. The final arrangement of holes developed as the work progressed, and was programmed in accordance with the varying conditions of the subsurface material in the different localities, as indicated by the results of the tests.

DRILLING AND GROUTING.

The holes for introducing the grout into the foundation material were put down with Davis Calyx Core Drills. Four were installed early in the work, and later on three more were added, making a total of seven, operating night and day, in ten hour shifts. The whole operation extended over a period of about one year.

The outside diameter of the bit was 2 7/16

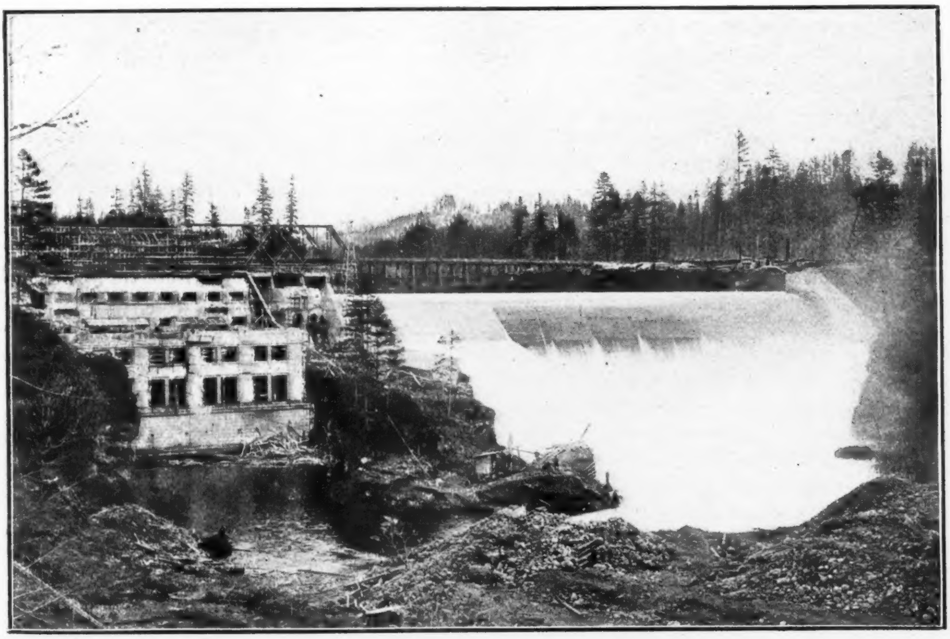


FIG. 2. THE SPILLWAY.

inches, drilling a hole approximately three inches in diameter. In advance of the core drilling, 3-inch wrought iron casing pipes were set to a depth of from five to six feet into the rock and grouted, the upper ends projecting about a foot above the surface, and threaded to permit the attachment of the testing and grouting apparatus. The holes for the casings were put down with a Burley steam drill, using a five-inch bit.

It was the early practice to drill a number of adjoining primary holes before doing any grouting, but this was found to give unsatisfactory results, on account of the free communication existing between the holes. The grout would travel from the one into which it was being introduced, to others communicating with it, with the result that the latter would eventually become choked, without having the benefit of the pressure directly applied to them, as was desired in order to accomplish the widest diffusion of the grout, throughout the material surrounding each hole.

To overcome this, the plan was adopted of distributing the drills over as wide an area as was practicable, and each hole was then tested and grouted immediately upon completion of the drilling, and before putting down any other hole nearby, that might be affected by the communication of the grout. At times, the congested state of the work interfered somewhat with the execution of this plan, but on the whole, it was successfully carried out.

The method usually followed in grouting, was to make connection between the grout tanks and the casing by means of a flexible copper hose, and introduce the grout at the top of the hole, but in order to prevent, if possible, the rapid choking of the hole with cement, which frequently occurred, the method of introducing a pipe into the hole, and discharging the grout at various depths was tried out. For this purpose a 2-inch pipe, made up in sections, was used, and the operation was started with the same inserted to within a few feet of the bottom of the hole. When the hole gave evidence of tightening with the pipe in this position, one section was detached, usually ten feet in length, thus raising the outlet, and the operation repeated. At intervals a charge of water was shot in, to keep the pipe from plugging, and also to loosen up the cement that settled in the hole. This method of grouting through the pipes, was given a thorough trial, but so far as could be observed, it had very little advantage as to the amount of grout the hole would take, over the less laborious operation of introducing it directly at the top. The changing of the position of the pipes also interrupted the continuous flow of the grout, which it was desirable to maintain in order to accomplish the best results.

The consistency of the grout was varied to meet the different conditions, one part of cement to five of water appearing to give the best results, but the proportions tried out varied from 1 cement—2 water to 1 cement—15 water.

The grout was forced in under air pressure ranging from 50 to 200 lbs. per sq. in., depending on the tightness of the hole. While it was desirable to use the higher pressures, in order to accomplish the greatest diffusion, it was not always practicable to do so, on account of it blowing out at the surface.

EQUIPMENT FOR DRILLING AND GROUTING.

The drilling and grouting outfit consisted of six Davis-Calyx Drills (Mfg. by Ingersoll-Rand Co.) Type G. O. and one Davis Calyx Drill, Type G-4. 1,119 ft. of the drilling was done by two steam driven diamond drills, Type B, which were later removed. The Calyx Drills were electric driven by 5 HP. shunt wound D. C. motors, 550V, 8 amp., 1800 R. P. M., belting from 5 inch pulley direct to 12 inch drill pulley on shaft with 12 inch spur gear meshing with 3 inch spur gear, giving drill spindle a speed of 187 R. P. M. 2 7/16 inches outside diameter diagonal slot shot bits cutting a 1⅝ inch diameter core were used with six foot core barrels of hydraulic 2 inch wrought iron pipe. For soft material, four pointed cutter bits were used with same core barrels. Drill rods were 1½ feet, 5 and 10 feet in length. Drills were equipped with usual accessories, lifters, 24 inch Trimo and Stillson wrenches, water plugs, etc. The wash and shot water used was taken from supply tanks at average head of 97 feet. Labor employed for drilling was white, wages (driller), $0.30 per hour; helper, $0.25 per hour for 10 and 12 hour shifts.

The total net cost of drilling and grouting was $47,770.55, or $1.40 per lineal foot.

Total net cost for drilling and grouting, allowing for salvage on plant, $41,861.55, or 1.23 per lineal foot.

Of the total footage drilled, 32,919 lin. ft.

was put down with the Davis Calyx Shot Drills, owned by the P. R. L. & P. Co., and 1,119 lin. ft. by Diamond Drills owned and operated by the Sullivan Machinery Company, working under a cost plus 25 per cent. contract. The holes put down with the diamond drills cost about one-third more per foot than those with the shot drills, on account of the more skilled operators required, in addition to the contract commission.

PROGRESS IN COMPRESSED AIR PRACTICE

The following is an abstract (mostly as prepared by the editor of *Power*) of a paper by George Barr, read before the Manchester Association of Engineers. It will be seen that it refers to English practice entirely, and in some particulars is at variance with American practice, as for instance where the writer says that present day designs of air compressors are mostly vertical.

For pressures from 70 to 100 lb. the compressor is generally two-stage. In a general way the above description covers the major portion of compressed-air plants with piston speeds up to 500 or 600 ft. per min. Valve gears of combined mechanical and automatic type, or of light multiple-ported small-lift types, are employed and clearance spaces are down to 2 or 3 per cent. When in some instances old compressors of the first mentioned design, or somewhat similar, were discarded and a new plant installed, the results obtained easily explain why compressors have for long been considered inefficient. To demonstrate what can be done by installing new machines a case is mentioned where a compressor of four times the capacity of the old machine taken out required only the same amount of steam per hour.

When considering the general question of compressed air efficiency it is necessary not only to examine the compressor, but the pipe lines and the plant consuming the air must be considered; in this direction there has been great improvement. Taking a wide view of the matter few engineers have given much study to compressed air and have taken for granted that what has been must still continue. Looking at the matter from this standpoint, what is generally found in inquiries issued for large compressors? The capacity of the machine is given; if steam driven, steam pressure and vacuum are mentioned; if electrically driven, voltage. It is not general that steam consumption is asked, and on rare occasions is a capacity test called for. Such a test when made is seldom, if ever, any check on the output of the machine, the test generally being to fill a reservoir of given capacity from atmospheric pressure to final working pressure. The temperature of the air may be taken or may not, and when taken is generally misleading and possibly allows of error up to 10 per cent. In fact, it is questionable whether there is one compressor at work at the moment, the actual capacity of which is known correctly through a test.

The actual proof that any given machine is really delivering the full amount of air specified is not, of course, sufficient to prove the machine the best possible, as some designs may require more power to compress the air, due to small restricted air passages, poor cooling arrangements, low mechanical efficiency, etc. On the other hand a machine may not have a long life at a high state of efficiency. After all what the user wants is a machine to show small horsepower for air actually delivered, and a figure representing horsepower to compress say, every 100 cu. ft. of air per minute, covers volumetric efficiency, mechanical efficiency, losses in compression, etc.

Taking a reciprocating two-stage air compressor, it will be found that a figure such as 20.5 electrical horsepower is required to compress and deliver every 100 cu. ft. of air up to 100-lb. pressure. Such a figure might reasonably be expected as "covers" for, say, 90 per cent. motor efficiency. For steam-driven machines the indicated horsepower in the steam cylinder per 100 cu. ft. of air compressed as above, should be about 20.

Passing to present designs and bearing in mind the present tendency to install more of such plants in collieries and shipyards, it might not be out of place to give an idea of the general tendencies. First it is found in a general way that colliery units range from about 1,000 to 5,000 cu. ft. and the electrically driven units from 1,000 to 3,000 cu. ft. with unit horsepowers from, say, 200 to 600. These represent plants placed on the bank and power drawn from local power companies' mains. In some quarters there seems to be a tendency to try in the mine smaller semi-portable sets of strong and efficient design, with more attention given to strength and simplicity than was

hitherto the case, when lightness was considered the main necessity.

Comparing overall efficiency of the electrical methods with a large steam-driven compressor on the bank, Mr. Barr gives the following electrical plant assume the current generated losses. In the steam-driven machine the mechanical loss is 10 per cent. and transmission losses, including leakage, 7 per cent. For the at the power house, as it will be found in a general way that the losses in the generation will equal the extra charge for the power as made by the power company. Then there are 10 per cent. mechanical loss in the engine, 10 per cent. loss in the dynamo, 5 per cent. loss in the transmission for the small semi-portable machines and 10 per cent. loss in the motor driving the compressor.

For large mortor-driven machines the same allowance of 7 per cent. loss for air transmission must be made as in the steam-driven sets, and for the small semi-portable sets there is a loss of 3 per cent. for the short air piping and leakage. These figures are all relative, but are a fair mean for all the cases. Steam losses therefore equal 17 per cent., large motor sets 37 per cent., and small motor sets 38 per cent., or a difference of 20 and 21 per cent., respectively, representing a margin to cover extra price paid to power companies, or a figure which will make it possible to decide whether extra interest could not be readily paid on the extra capital for the steam-driven sets, together with the difference in running cost and upkeep of both schemes.

Mr. Barr reviewed the changes which have taken place in detail of construction, such as cooling arrangements, governing, lubrication, valve gear, etc. Summarizing he finds with a large installation of four machines of, say, 2,500 cu. ft. capacity each, first, no automatic stopping gear is wanted, as there will be an attendant who can be made use of for any starting or stopping actually wanted over a given day. But if in an electrically driven plant one of the sets had a variable-speed motor to give a desired range when all the plant was in use, this would cover all actual requirements. However, an additional controlling gear arranged to allow so much air to be discharged before compression starts, would give a plant covering all possible fluctations and assure high efficiency over varying conditions, with the extra advantage of being reasonably cheap.

At the moment automatic valve gears are those most used, and certainly it would appear that the greatest progress has been made in this class. They take the form of a multiple-ported or grid valve with very small lift, the form of valve, fixings and springs being covered more or less by various patents. Should an examination be made of indicator diagrams taken from one of the latest high-speed machines with multiple-ported valves, it would be apparent that the losses due to throttling either on the inlet or discharge are very small and leave little margin for improvement in this direction.

Where is was common to install single-stage machines for pressures of say, 60, 80 and even 100 lb., two-stage compression is now most common. An increase in compressor efficiency of say, 10 to 15 per cent. is obtained in large size units, which also makes for greater reliability due to absence of heating troubles. Further, cooler and drier air in the system can be secured, but it is necessary to have intercoolers of reasonable size, 1 sq. ft. of cooling surface for every 4 cu. ft. of air compressed to 100 lb. not being too large. The intercoolers are also better if placed outside the engine rooms in the atmosphere, say on the shaded side of the building. The cylinder cooling in the best makes of machines may be taken as generally the most efficient possible, as most compressors now have jackets carried entirely around the cylinders and covers.

Referring to the question of reheating, Mr. Barr admits that it would certainly add considerably to the efficiency of a compressed-air installation. In collieries, however, the air is not used at one particular spot; to heat the air immediately after leaving the compressor to, say, 350 deg. F. and then pass it along a distance of perhaps 1,000 ft. is simply wasting money.

With newer designs of machines where piston speeds are higher, more care must be taken of air-cylinder lubrication. In fact, more trouble develops from the use of unsuitable oils in the cylinders than is necessary. The same conditions do not prevail in an air cylinder as in the average steam cylinder, where condensation can always be depended upon to assist towards lubrication. In the air cylinders, although there is moisture in the

air, this will not deposit at the high temperature. In fact, the air cylinders will run very dry and seizures will be the rule if proper care is not taken. For air-cylinder lubrication an oil with high flash point is needed, which will leave little or no deposit, such as high-class gas-engine oil.

These remarks do not refer to compressors other than the usual machines for pneumatic tools and uses requiring similar pressures. For higher pressures machines of three- and four-stages are necessary.

Air compressors can now be had very much higher in efficiency than ten year ago. More care is being taken in the layout of piping systems, and if this betterment were carried into the plant which consumed the air, there would be shown in such places as collieries, results equal to the best electrical schemes. This statement does not suggest that over an instantaneous reading an overall efficiency could be shown with air equal to electricity, but taking a year's comparison with all upkeep charges, running cost and interest on differences in invested capital, or in other words the cost per ton of coal raised averaged over a year, the costs would be much the same. This is the correct test and the efficiency which really matters.

COMPRESSED AIR FOR OIL FORGES IN A NAVY YARD*

The casual observer, walking through any smith shop, will probably be of the opinion that 75 per cent. of the workmen employed therein are loafing. There is a general air of standing around, this condition being caused, of course, by waiting for heats. Time studies on this class of work show what a large percentage of time is lost in this manner, and when it is considered that the smith and his helper, or the heavy forging gang are high-priced day men, the money loss is easily seen to be a high one.

Any method that reduces this waste, materially increases production and decreases cost, and this is the main advantage of oil forges and furnaces.

The smith shop at the Portsmouth Navy Yard, formerly consisted of a heterogeneous collection of coal and gas forges and gas furnaces. It is now equipped with 25 open forges, two rivet and bolt furnaces, and three large furnaces, all served by oil. There is also at present one coal forge used for welding stanchions, this being the only class of work for which the oil forge has been found unsuitable.

The oil used is a rather heavy fuel oil with a specific gravity ranging from 0.8755 (30 deg. B.) to 0.9465 (18 deg. B.). It is received in tank cars which are emptied into large storage tanks located underground about 100 yd. from the smith shop on the waterfront. The oil is pumped from these large storage tanks to a small ready-supply tank located in the blower room of the shop, the pump being also located in the same room.

This ready-supply tank has a capacity of 400 gal., and is usually pumped up twice a day so as to insure a sufficient supply of oil at all times during the day to the forges and furnaces. The oil is then forced through a 2-in. main to the burners of the various forges and furnaces of the shop by an air pressure of about 25 lb., which is put on the ready-supply tank from the yard air mains, a suitable reducing valve, of course, being used to secure the step-down in pressure from the yard air mains.

This 25-lb. pressure also performs the required atomization of the oil for combustion. Air for combustion is supplied through a separate pipe (formerly used in the old gas system) to the burners by two large blowers, each having a capacity of 1,200 cu. ft. of free air per minute at a pressure of 5 lb. per in. One of these blowers is operated by being directly connected to a 60-hp., variable-speed, direct-current motor, while the other blower is direct connected to an 85-hp., constant-speed motor. Both motors operate at 220 volts.

The variable-speed motor is capable of taking care of the average load, which consists in supplying air to about 12 open forges and 2 furnaces, and is the motor which is in daily operation. The constant-speed motor blower is provided so that it may be run in case of injury to the variable-speed motor, or in case there is an extra large load on the shop.

It is considered desirable to provide two small units for supplying air for combustion not only for the reason just given, but also because the efficiency of the motors is greater when running under full-load conditions. Both blowers, of course, discharge into the same

*Abstract of article by C. A. Harrington in *American Machinist.*

air lines when both are running, or each running separately.

Complete combustion is secured in the forges with the air pressures above noted. This is readily seen by the absence of smoke in the shop, a condition which immediately appeals to the visitor, and by the absence of any carbon deposit in the forge. No method is provided for heating the oil before delivery to the burner, the system, as designed, not providing for this and the necessity therefor not having yet arisen.

The absence of smoke is an important advantage of oil forges over coal, in that the latter is a very much dirtier installation, not only due to smoke, but also to the small particles of coal and dust thrown into the smith's face by the constant stoking of the coal fire. With oil forges, both the smoke and the necessity for stoking disappear.

It is, of course, impossible to say, owing to the large number of variable factors present, just how much the output of the shop has been increased by the introduction of oil. In forge shops, production is chiefly dependent upon the time occupied in doing useful work, and by taking a sufficient number of careful time studies in both oil and coal forge shops of similar character, say government shops, a close approximation of comparative efficiencies might be obtained.

It is believed that such an investigation would show a substantially increased efficiency for the oil forge shop, and it can be stated that this increased efficiency is not injurious to the workmen. The installation of oil forges at the Portsmouth Navy Yard has been conspicuous for the absence of any complaints on the part of employees, and not a few have expressed a preference for the oil forge.

The French mushroom industry is located chiefly in Paris and vicinity. This culture is carried on most extensively in subterranean quarries at a depth of 60 to 200 feet from the surface. These quarries have been found extremely profitable in this connection, owing partly to their equable temperature and their freedom from drafts, provision being made, however, for their proper ventilation. They rent for $30 to $80 per year, according to the length of their galleries (which sometimes extend over several miles), their height under cover and their ventilation facilities.

ENERGY OF EXPLOSIVES AND TOUGHNESS OF ROCKS

The percussive or shattering force exerted by different explosives varies greatly, and the propelling force increases in the same ratio as the decrease of percussive force. In blasting, both kinds of work are required from the explosives used, the nature of the rock determing the explosive that should be used.

Among common explosives the following list is arranged in the order of decreasing percussive force and increasing propellent force, viz.:

HIGH PERCUSSIVE FORCE.

Nitroglycerine,
Blasting gelatine,
65 per cent. dynamite,
50 per cent. dynamite.
30 per cent. dynamite,
40 per cent. ammonia dynamite,
40 percent. gelatine dynamite,
Granular nitroglycerine powder,
Black powder—fine grained,
Black powder—coarse grained.

HIGH PROPELLENT FORCE.

The percussive force of an explosive produces the cracks and fissures first required in blasting; but the effect of the blast is not complete without the heaving or propellent force that sets the pieces in motion. The explosive to be chosen for a given work is the one that combines these two forces in the right proportion. An excess of percussive force breaks the rocks too fine and packs the fragments too closely together. An excess of propellent force will throw the pieces too far, with dangerous results.

The following table shows the comparative toughness of some common rocks, as compared with limestone:

Fresh diabase	3.0
Sandstone	2.6
Fresh basalt	2.3
Hornblende granite	2.1
Quartzite	1.9
Feldspathic sandstone	1.7
Calcareous sandstone	1.5
Granite	1.5
Slate	1.2
Dolomite	1.0
Limestone	1.0

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CONTENTS

HUMAN DRUDGERY TRANSFORMED

Perhaps in no particular is the progress of the human race more strikingly indicated than in the entire transformation of its primitive and typical drudgeries, the hewing of wood and the drawing of water. In the earlier estate of man no occupations were rated lower, were more constantly exacting or employed so great a proportion of hopeless toilers than those which had to do with the first essentials of his physical existence.

Now is the race not only emancipated from the slavery entailed by its prime necessities, but both the work and the worker have been changed in attitude and status. To-day the hewing of wood, or the providing of fuel, and the drawing, storing and conveying of water for domestic and industrial and agricultural uses engage the highest abilities of the most eminent of the world's engineers. Indeed, the challenge of the primitive occupations has been a principal stimulating and impelling agency in the upbuilding of the engineering profession. Engineering skill now finds its most exacting tasks and its most substantial triumphs in the construction of such works as the Los Angeles and the Catskill aqueducts.

These are spectacular and world famed works, and not only are the successful builders of them to be appreciated and rewarded but the entire mass of men clear to the bottom are benefitted and to be congratulated. Yet besides the great constructions for the water supply of the Metropolis and the larger cities, all the smaller aggregations of humanity now similarly have their respected and valued drawers of water, and in the aggregate their work would measure up well with that which the world so justly boasts of. Under modern methods not only is water provided, as we might say, everywhere in unfailing abundance, but it is also pure and wholesome and health stimulating as was never known before. It is significant of the trend of the times that The Old Oaken Bucket is no longer regarded with respect or affection, and it has taken its place among the things that were, but are no more.

One of the earliest of the devices by which it was attempted to evade the drudgery of water drawing was in the employment of the wind mill for the purpose, and it may be said of it that it brought relief locally and temporarily, but that it was inadequate for the

task as a whole, and its ultimate lot has been to illustrate the picturesque in its decay.

It is a curious thing that in our latest and most advanced methods of water getting we turn again to the atmosphere as our most efficient helper, although the wind mill and the air lift are apparently as far apart as mechanical devices employed for the same purpose could well be imagined. It is not easy to realize all that the air lift has in it for humanity to-day, or the promise that is in it of extended and unlimited service in the future. It has a field of its own in which it is absolutely without a competitor. It gets water in copious flow where no other device could reach it, and it gives water that is above suspicion. It does not work for nothing, neither does it charge excessively, and as things go we may say that it is sure of employment into the far future.

NEW BOOK

The Gas Turbins, Theory, Construction and Records of Results obtained from Two Actual Machines, by Hans Hotzworth, Engineer, translated by A. P. Chalkley, B. Sc. (London), A. M. Inst. C. E., A. I. E. E. J. B. Lippincott Company, Philadelphia. 148 pages, 9 by 6¼ inches. 142 illustrations and many tables. Price $2.50.

Messrs. Korting Bros. of Hanover, built the original turbine to the author's designs, and the first turbine employed for actual driving (300 to 800 H. P.) was constructed by Messrs. Brown Boveri & Co., of Boden-Manheim, who also supplied the dynamos and blowing plant. The book represents thorough and conscientious work and embodies data not before obtainable. It should prove of great value to many engineers who need to be informed of the latest developments of the newer types of motors.

CONFIDENTIAL EMPLOYMENT DEPARTMENT

18. Young man who has had extensive experience in English mines with all classes of coal mining machinery. Now located in Canada.

19. Quarry man who has held superintendent's position for years. Also experienced in railroad construction and iron mining.

TAKING A HINT FROM CONTRACTORS' BIDS

W. L. Saunders, president of the Ingersoll-Rand Company, was put in charge of the Bedloe Island channel soon after his graduation from the University of Pennsylvania. This was in 1880. In connection with this work he had some rock excavation to do. Contractors' bids ranged from $1 to $40 per yard. The remarkable variation convinced him that they did not know about such work and would be unsafe to rely upon. Rock-drilling was not then the well known art it is now. So Saunders decided to do the job himself on the theory that he knew as much about it as any of the would-be contractors, and could more surely learn what he didn't know. He bought four Ingersoll drills and went to work. This led to an acquaintance with the Ingersoll Company and before long an association with it, which has continued ever since. The company then had five officers and employed 60 men. Now it has 260 officers and 4,000 men. —*Engineering and Mining Journal.*

MEASURING DEVIATIONS OF DIAMOND-DRILL HOLES

BY SIDNEY L. WISE.*

It is not my purpose to discuss the many methods in use for determining the dips and lateral deviations in bore-holes, but simply to give a concise outline of the obstacles encountered and the results obtained in a recent survey of a series of holes. These were drilled at various inclinations in order to intersect the supposed continuation of a lens of pyrrhotite and chalcopyright, the ore body following closely the foliations of the country rock. The lens dips at an angle of about 66 degrees, and the fact that there is also a pitch to the ore body renders the pointing of the boreholes of considerable importance, to avoid missing the lens.

The country rock may be briefly described as a micaceous and sometimes garnetiferous schist, although the encountering of a hornblende gneiss is by no means rare.

The difficulty encountered in rotating the drill rods was one indication that the holes

*Engineer for the Vermont Copper Co., So. Strafford, Vt.; in Columbia School of Mines Quarterly.

were not straight, and it was therefore decided to survey them. Due to the magnetic properties of pyrrhotite, compass methods were out of the question, but it was decided to determine the variations of dip by the hydrofluoric acit etching method.

For holes of over 600 ft. depth, the regular drill rods were employed to lower the acid bottles into the holes, while for shallower holes a heavy copper wire, mounted on a reel, was used for the lowering. The etching agent was a mixture of concentrated hydrofluoric acid and water. For shallow holes, one part of acid to two parts of water were used, but for deep holes one part of acid to four parts of water were employed. In the former case, 20 minutes were allowed for etching, whereas it required 70 minutes to procure a clear etching when using the weaker mixture.

The etching solution was placed in a bottle of the kind used for homeopathic medicines. This bottle was selected because of its uniform interior and exterior diameters, and because of its strength. The bottles were corked very tightly by rubber stoppers, and then were placed in cylindrical steel containers of the following general design:

Each container is made in two parts, which have respectively a male and female thread. This threading is very close, and rubber gaskets are used to prevent water from leaking into the container. Trouble was experienced from this cause, due to the great hydraulic head to which a container is subjected when down 600 ft. or more. The inside of the container is cylindrical and is just large enough to contain the bottle. If water leaks into the container the pressure may be great enough to break the glass bottle inside. On the outside of each end of the container is a thread, which can be screwed into the drilling rods. The outside diameter is the same as that of the rods used, which insures that the container will lie in the true course of the hole. The length of the container, including threaded ends, is 1 ft. By placing containers between rods, at intervals, etchings were taken simultaneously at four successive 100-ft. spaces. The etching appears as a thin translucent line on the inside of the bottle.

Previous experience has shown that the angle obtained by reading the etching is not the true angle of the hole at the corresponding point. Capillary attraction causes the liquid to climb up higher on the upper side of the bottle than on the lower side. This causes the etched line to indicate a steeper dip than the actual and hence a negative correction is necessary for every reading. Laboratory experiments show that the capillary attraction varies with the dip of the bottle. They further show that the maximum attraction takes place at about 45 degrees, with a constant increase in the necessary correction from 0 degrees to 45 degrees, and a constant decrease from 45 degrees to 90 degrees. The correction when the bottle is inclined at 45 degrees is about 8 degrees. The capillary attraction also varies with the strength of the solution as well as with the diameter of the bottle, and it is therefore necessary to make the laboratory test under conditions as close as possible to those occurring in actual surveying.

The following results of a survey of one of the holes may be of interest, as it shows a remarkable flattening of the hole during diamond drilling, using the customary, rigid, steel rods:

Depth in feet.	Corrected dip of hole.	Depth in feet.	Corrected dip of hole.
100	56° 40′	600	32° 20′
200	53 40	700	31 15
300	49 45	800	29 15
400	41 50	900	20 30
500	36 50	1,000	26 40

This hole was started with a dip of 61 degrees 30 minutes and it is interesting to note that a depth of 1,000 ft. the hole was inclined only 26 degrees 40 minutes with the horizontal.

THE WATER WE "CONSUME"

Each individual drinks in course of a year about one ton of water, but this is only a small fraction of what you use for the support of the human machine. In the course of a twelvemonth you eat the equivalent of two hundred pounds of bread and two hundred pounds of meat, that is to say, four hundred pounds of food. But the bread and meat must themselves be produced directly or indirectly from the soil, and this can be accomplished only by large expenditure of water. Plants will not grow without water. To produce the grain necessary for making two hundred pounds of bread at least four hundred tons of water are required. Thus we begin to get a notion of the really enormous indirect consumption of water by the individual human

being. He cannot get along without it. If a man was reduced to an allowance of say one thousand tons of water a year he would soon die.

"OXYBENZ" WELDING

Autogenous welding in which the usual acetylene is replaced by any of the lighter hydrocarbons seems to have advanced beyond the experimental stage in some of the European countries and is now being advocated and practiced by at least one company in England. The chemical composition of the lighter hydrocarbons, such as benzol or petrol, is very similar to that of acetylene, and it is claimed that after vaporization and burning with oxygen nearly as high a temperature is produced as with acetylene. The chief claim for this system is economy in installation and low cost of working. It has a further advantage that it is extremely portable, and fuel for working it can be obtained in all civilized countries, for oxygen is used wherever the medical profession is represented, and petrol, benzine, benzol or any of the other hydrocarbons can be used with it. The limitations of the process are found in the fact that the flame temperature is not quite as high as with acetylene, and in consequence welding by this method takes somewhat longer. For thin sheet metal work this time is not of much value, but in welding heavier material heat is transmitted from the part to be welded to the body of the metal, thus making it rather uneconomical, as the reduced cost of fuel is more than balanced by the additional time taken by the operator, who must be highly skilled, and consequently well paid. This very fact points to an advantage in dealing with work which is liable to distortion if heated intensely in one spot, because the fact of it taking longer to achieve welding temperature will allow a bigger body of metal to become heated to a temperature more near that of the part being welded.

In cutting by this method, where cheap labor can be utilized, the additional time is very much more than balanced by the lower cost of the liquid fuel, and where machine cutting is in vogue the saving is considerable. The usual oxygen bottle is used and the same pressure regulator, but a pipe is carried to a steel bottle somewhat similar in construction to the well-known laboratory wash-bottle, the pressure on the surface of the liquid being obtained from the oxygen cylinder, so forcing the fuel along a tube to the blow-pipe. The benzol bottle is fitted with a safety device.

A minor advantage possessed by the "oxybenz" method is that the pipe carrying the oxygen and the liquid to the blow-pipe is of very neat construction; furthermore, it is much lighter than those used for the oxy-acetylene method. A rubber tube is used to carry the oxygen and is surrounded by a thin flexible tube which carries the benzol and practically armours the inner rubber tube. A bye-pass is arranged at the nozzle of the blow-pipe to keep the end hot, so as to vaporize the benzol when it reaches there. The one disadvantage this system possesses is that the end of the blow-pipe has to be heated by an outside flame before the fuel will evaporize and mix with the oxygen to form the proper ignitible compound. In the standard set supplied by the company the blow-pipe is fitted with nine interchangeable tips to make it suitable for work of various dimensions, the whole outfit comparing favorably in price with a high pressure dissolved acetylene system to which its capabilities are most closely allied.

NOTES

Granite is two and two-thirds times as heavy as water; its specific gravity is 2.663. A cubic yard of granite weighs exactly three-quarters of a ton. The strength of granite is tremendous, although the different granites vary greatly. Poor granites will withstand a pressure of 18,000 pounds to the square inch. Good, close-grained granite will withstand 30,000 pounds; but certain Wisconsin granites have withstood a crushing pressure of 43,973 pounds to the square inch—twenty-two tons weight resting on a tiny cube of stone not much larger than a lump of sugar.

The development of the metallurgical industry in Belgium has been such that that country is now the largest *per capita* consumer of pig iron in the world, using annually 738.5 lb. of pig iron per inhabitant, while the United States comes second with 650.4 lb. Next in order of importance are Germany with 482.2 lb., England with 447.5 lb., and France with 242.5 lb. As regards steel, Belgium occupies second place with an annual consumption of 418.9 lb. per head of the population, as com-

pared with the United States consumption of 617.3 lb. per head. Germany follows Belgium with 396.8 lb., England comes next with 308.6 lb., and then France with 196.2 lb.

A demonstration has been given at Southport, in England, of a vacuum street sweeper brought out by a Sheffield firm. The machine, which is the invention of an Italian engineer, resembles an ordinary automobile, and is fitted with an apparatus producing a suction effect. It is claimed that the machine will sweep a road or street without raising any dust and without causing any damage to the surface.

The bubble of a good carpenter's level indicates variations of level in the ratio of four to one to the foot. Thus in a length of one foot a change from level of $^1/_{64}$ inch should change the position of the bubble in the glass $^1/_{16}$ inch. The highest grade precision levels magnify variations from a level plane thirty-two times. Hence a precision level one foot long should indicate a change of height of 0.0001 inch at one end by a bubble movement of 0.032 inch, an amount easily seen with the naked eye.

When you are afraid that some one will find out what you are doing, and especially how you are doing it, take this verse of Kipling's for a bracer:

"They copied all they could follow,
But they couldn't copy my mind,
And I left 'em swearing and stealing
A year and a half behind."

There is nothing to fear in a stern-chase of shop ideas.

A quick job of cutting up steel building wreckage was recently done in Baltimore. The building was destroyed by fire and the frame was a mass of buckled and twisted members, largely 10-in. steel channels. The plant used was a No. 3-T oxyacetylene welding and cutting plant manufactured by the Alexander Milburn Company. It was mounted on a truck to facilitate moving, and 50-ft. lengths of hose were employed, thus giving a considerable range for each position of the truck. By its use one operator and helper with a single torch were enabled to cut up iron into movable lengths faster than a force of five men could load it on rail trucks and take it away.

One of the clever wrinkles for saving labor on the automobile is an impulse air pump which can be applied to any one of the cylinders in place of the spark plug and used for pumping up the tires. The device consists essentially of a small differential piston working in a cylinder fitted with suitable valves. It is operated by running the engine with three or five cylinders, the cylinder to which the pump is connected being dead, of course, because the spark plug is removed. The air compressed in the cylinder is driven through the pipe connecting with the differential piston and drives it upward. The small piston connected to the larger piston compresses a small charge of air to a higher pressure and forces it into the tire. The residual air remaining in the small cylinder "kicks" the differential piston down as the engine cylinder makes its down stroke, the momentum being sufficient to complete the stroke and draw in a fresh charge of air.

The administration of the Russian railways is seriously occupied with the project of a tunnel of gigantic proportions through the Caucasus Mountains. This tunnel, the largest in the world, would have a length of nearly 16½ miles, and it has been already the object of a conference between Russia and foreign engineers, who have found: 1. That the geological structure of the mountain does not present any great obstacles. 2. That during the borings of the galleries no such difficulties will be encountered as during the borings of the Simplon tunnel. 3. That the temperature can be maintained at about 77 degrees Fahr. 4. That the elevation of the tunnel being between 4,300 and 4,650 feet, there is no danger of encountering subterranean water courses. 5. The work will take about eight years. This great undertaking would insure a direct connection between Vladikavkees and Tiflis.

Austria-Hungary is the fourth largest coal producing country in the world, although three states of the United States are much larger producers. In 1910, Austria-Hungary mined 53,600,000 tons of coal, which was less than one-fourth of Pennsylvania's production for 1911, whereas West Virginia produced nearly 60,000,000 and Illinois 53,683,000 tons.

A seven-foot vein of the finest anthracite coal has been uncovered recently by some rock-men of the Philadelphia & Reading Coal & Iron Company, while they were engaged in driving a tunnel at the Bear Valley shaft.

Increase in temperature with depth is a common phenomenon. It is usual to assume an increase of 1 degree F. for each 65 ft. of depth, but the actual increase is variable. Recorded figures are, 1 degree F. for each 33 ft. on the Comstock lode; 208 ft., on the Rand; 77 ft. at Bendigo; 80 ft. at Ballarat; 43.5 ft. in the Thames field, New Zealand; 32.8 ft. at Waihi.

Utah is unique among the United States in the diversity of its production of precious and semi-precious metals. It does not rank first in the production of any of these metals, but it stands well among the leaders in the production of gold, silver, copper, lead, zinc, and vanadium minerals. In the production of lead and silver it ranks third; fourth in copper; sixth in gold, and seventh in zinc.

Safety on the oil-burning ships in the Navy will be increased by the provision, on such ships, of an oxygen breathing apparatus. It is estimated that about 10 lives are lost each year on these oil-burning vessels, when men are overcome by gases escaping from the liquid fuel. The apparatus is simple, consisting merely of a small oxygen tank, a flexible tube, and a mouth piece covering the nose and mouth, but not hindering the vision as the usual helmet does.

In Germany ozone is used in connection with the ordinary processes of refrigeration. In the cold storage rooms attached to slaughter houses the temperature of the air is liable to be raised to a serious extent when the doors are left open for any reason; for instance, when meat is being put in or taken out. The micro-organisms of putrefaction immediately become active under such circumstances and the keeping quality of the meat is diminished. If the air of the cold storage room is ozonized, its temperature may be raised without injury to the contents.

As compared with the 38 feet per second, which is considered the limit in safe speed for a cast-iron flywheel, some of the peripheral speeds attained by the disks of steam turbines are striking. The highest peripheral speed which it is possible to employ is probably found in the 300-horsepower DeLaval turbine, in which with a 30-inch wheel running at 10,000 revolutions per minute, a velocity of over 1,300 feet per second is reached.

In drilling and blasting the Culebra Cut, both piston and churn drills have been used. The usual depth of hole, has been about 27 ft. the holes being spaced 14 ft. apart. They are loaded with 45 per cent. potassium-nitrate dynamite and fired by an electric current from a lighting circuit. About 2¼ cu. yd. of material is obtained per pound of powder. The explosive used is what is commonly called "straight dynamite," having a high velocity of detonation and good water-resisting qualities, but generating more noxious fumes than the gelatin or ammonia dynamites.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sendingn five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 4.

1,054,728. POWER DEVICE. MORRIS C. WHITE and OTHO C. DURYEA, Chicago, Ill.
1,054,754. FLUID-PRESSURE MOTOR. CLARENCE A. DAWLEY, Plainfield, N. J.
1,054,760. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. RUFUS B. FOWLER, Worcester, Mass.
1,054,765. DEHYDRATING APPARATUS. GORDEN DON HARRIS, Bay Shore, and JAMES S. POLLARD, Mamaroneck, N. Y.
1,054,775. SAND-BLAST APPARATUS. FOSTER J. HULL, Brooklyn, N. Y.
1,054,789. DIE-CASTING MACHINE. LAYTON M. PARKHURST, Indianapolis, Ind.

1. A die casting machine including a crucible, a conduit from the lower part thereof through which the metal may be forced to a die, means for supplying heat to the crucible, and means for applying *products of combustion under pressure* upon the metal in the crucible for forcing the same out through said tube.

1,054,807. AERATING-CHURN. WILLIAM S. H. WAILES, Pecos, Tex.
1,054,832. PNEUMATICALLY-PADDED BOXING-GLOVE. ALFRED DUNN, Philadelphia, Pa.
1,054,866. AIR-PUMP. CHARLES J. PILLING, Philadelphia, Pa.
1,054,947. ROTARY FAN OR BLOWER. FREDERICK R. STILL, Detroit, Mich.
1,055,004. AIR-PUMP. FRANK H. WALKER, Laporte, Ind.
1,055,161. FLUID-PRESSURE-OPERATED VALVE. HARRY G. GEISSINGER, New York, N. Y.
1,055,196. AIR-COOLER FOR AIR-COMPRESSORS. HARRY EDWIN MACCAMY, Spokane, Wash.
1,055,210. AIR-EJECTOR. DONALD BARNS MORISON, Hartlepool, England.
1,055,239. COMPRESSOR. JOHANN STUMPF, Berlin, Germany.

1,055,250. PUMPING MECHANISM FOR VACUUM-CLEANERS. VICTOR WINQUIST, Rockford, Ill.

MARCH 11.

1,055,308. FAN OR FAN-BLOWER. ISRAEL BENJAMINS, New York, N. Y.

1. In a fan or fan-blower two or more rotary units, each comprising a set of vanes and a set of steam turbine blades, said units being adapted to rotate in opposite directions in alternate order and to propel the air in substantially the same direction.

1,055,332. GAS-ENGINE STARTER. STEPHEN S. KRAYER, St. Louis, Mo.

1,055,343. APPARATUS FOR CASTING. FRED LLOYD MARK, Chicago, Ill.

2. In combination, a flask, vacuum producing means connected with said flask, a mass of porous material having a cavity therein disposed in said flask, and a layer of material of greater density associated with said porous mass in position to separate the vacuum producing means from the atmosphere, there being a sprue through said porous mass and said denser layer to said cavity.

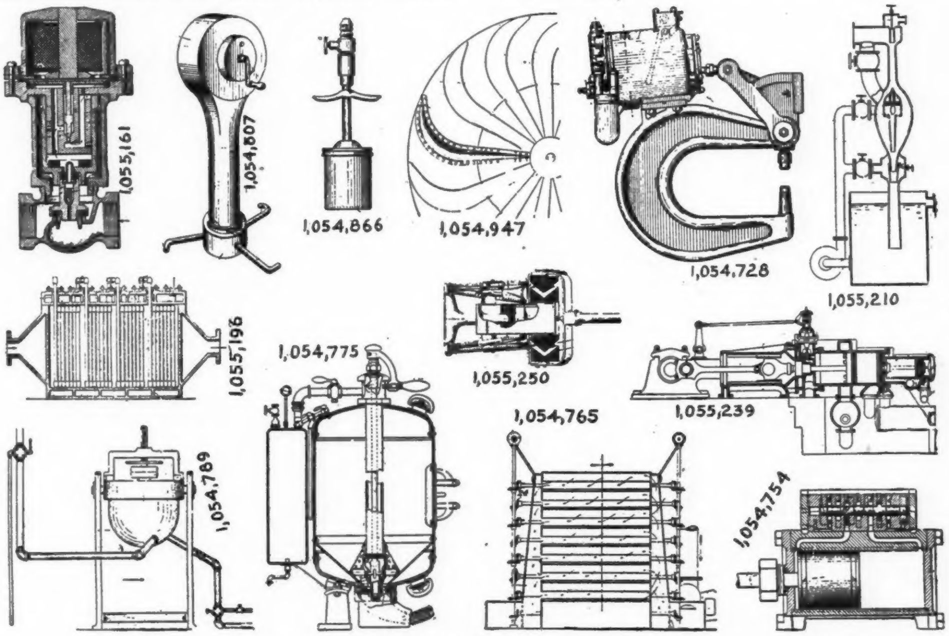
1,055,373. UNIFORM-RELEASE TRIPLE-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

1,055,411. OIL-BURNER. CLOYD C. MCWILLIAMS and JOSEPH MILLER, Schenectady, N. Y.

3. In an oil-burner, a casing beveled inwardly at its outer end, means for conducting fluid fuel and fluid under pressure to the inner end of the casing, a rotary member mounted within said inner end of said casing and movable in response to entering fluids and a mixer connected to and movable by said rotary member and comprising a conical portion fitting within said beveled end and provided with a series of blades against which the fluids are directed.

1,055,444. PNEUMATIC SLACK-ADJUSTER. CHRISTOPHER P. CASS, Maplewood, Mo.

1,055,557. PNEUMATIC POWER-TRANSMISSION MECHANISM. FRANK M. PRATHER, Los Angeles, Cal.



PNEUMATIC PATENTS MARCH 4.

1,055,605. PNEUMATIC PLAYER-ACTION. DAVID REDDIE CARSON and GAVIN WALLACE RUSSELL, Ottawa, Ontario, Canada.

1,055,611. CONVERTIBLE ENGINE AND COMPRESSOR. JOHN S. CLARKE, East Cleveland, Ohio.

1,055,661. COMPRESSOR FOR ICE-MAKING APPARATUS. CHARLES A. SANQUIST, St. Louis, Mo.

1,055,710. VACUUM-JACKETED RECEPTACLE. ANTHONY J. CONROY and JOHN T. SULLIVAN, New York, N. Y.

1,055,769. ENGINE-STARTING MECHANISM. CARL E. LIPMAN, Beloit, Wis.

1. In combination, a chambered casing having an exhaust passage, means for forcing air through the chamber of the casing to the said exhaust passage, a spray nozzle delivering to the chamber of the casing, an explosive motor exhausting into the chamber of the casing and having a water jacket and a pump delivering to the said spray nozzle through the water jacket of the motor.

1,055,734. AIR-CUSHION DEVICE FOR VEHICLES. JOHN G. FUNK, Swissvale borough, Pa.

1,055,844. PRESSURE-DRIVEN DRILL. ALPHONS L. WESTRICH, Salt Lake City, Utah.

1,055,845. MINE-LOCOMOTIVE. WILLIAM C. WHITCOMB, Rochelle, Ill.

1,055,857. PROCESS OF OPERATING PERCUSSIVE APPARATUS. HANS CHARLES BEHR, Johannesburg, Transvaal.

1. In a percussive apparatus, the process of delivering an uncushioned blow, which consists in forcing forward against a constant pressure a piston by means of a fluid under a varying pressure adapted to fall to a predetermined point; and in preventing said varying pressure from falling below said point while actuating said piston, substantially as described.

MARCH 18.

1,056,011. SMOKE-CONSUMER AND FUME-ARRESTER. JOHN J. DE MONT, Bayonne, N. J.

2. In an apparatus for the purpose set forth, the combination of a receiving tank, flues entering the same to supply smoke and fumes thereto, a gas collecting tank communicating with the receiving tank, gas outlet tubes in the said collecting tank, and an air blast pipe equipped with nozzles disposed concentrically within but spaced from the ends of said gas outlet tubes.

1,056,033. PNEUMATIC CLEANER. JOSEPH KUBOSCH, Milwaukee, Wis.

1,056,170. STROKE-SHORTENING DEVICE FOR PERCUSSIVE TOOLS. CHARLES C. HANSEN, Easton, Pa.

1,056,244. PROCESS OF EXTRACTING NITROGEN FROM AIR. EDWARD M. WILEY, Adams, Ind.

1. The herein described method of reducing the proportion of nitrogen to oxygen in air, consisting in directing air under pressure into a high pressure tank, setting up a circulation of water through said tank to saturate the water with oxygen and nitrogen, directing the saturated water into a low pressure tank to separate the oxygen and nitrogen therefrom, withdrawing the gases from the low pressure tank and directing them under pressure into a second high pressure tank, directing a current of water through said tank and through a low pressure tank to produce a mixture having a smaller proportion of nitrogen to oxygen and directing overflow gas from said second high pressure tank back to the first high pressure tank, and utilizing the overflow from the first high pressure tank for actuating the air and water forcing means.

1,056,250-1. VALVE FOR PERCUSSIVE TOOLS. LEWIS C. BAYLES, Easton, Pa.

1,056,288. ROTARY BLOWER. NEIL W. MACINTOSH, New York, N. Y.

1,056,426. PNEUMATIC SOLE FOR SHOES AND BOOTS. JOHN P. KENNY, Rochester, N. Y.

1,056,506. AIR-HOSE COUPLING AND UNCOUPLING TOOL. CHARLES L. COURSON, Pitcairn, Pa.

1,056,511. AIR-COMPRESSING APPARATUS. JOHN DESMOND, Wilmette, Ill.

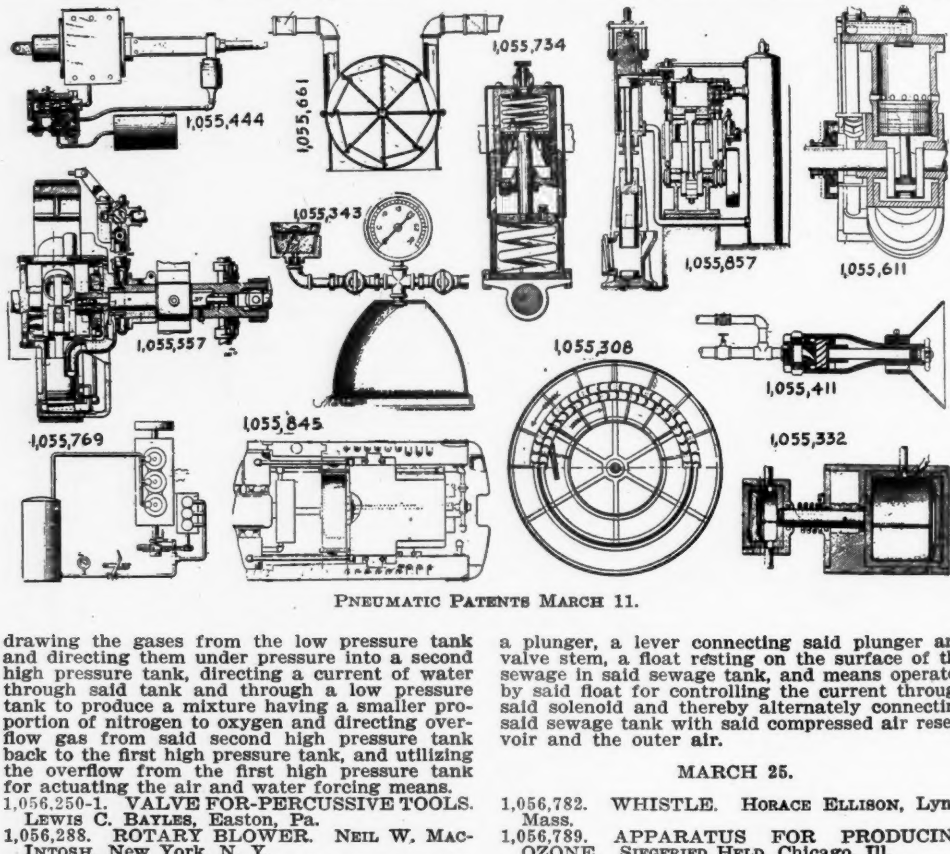
1,056,513. METER FOR MEASURING ELASTIC FLUIDS. AUSTIN R. DODGE, Schenectady, N. Y.

1,056,688. CENTRIFUGAL APPARATUS FOR PUMPING AIR OR GAS. WALTER KIESER, Berlin, Germany.

1,056,689. ROTARY COMPRESSOR. WALTER KIESER, Charlottenburg, Germany.

1,056,709. PUMP. HENRY J. POLLACEK and WILLIAM E. POLLACEK, New York, N. Y.

A sewage-level control system comprising a sewage tank having valve controlled intake and discharge pipes, a compressed air reservoir, a valve casing having two communicating chambers, one of which is connected with said sewage tank and the other of which is connected with said compressed air reservoir, a second valve casing having two communicating chambers one of which is connected with said sewage tank and the other of which is open to the outer air, valves arranged in said valve casings and controlling the communication between the chambers therein, a valve stem common to and carrying said valves, said valves being so arranged that when the opening between the chambers in one casing is closed, the chambers in the other casing are in communication, a solenoid provided with a plunger, a lever connecting said plunger and valve stem, a float resting on the surface of the sewage in said sewage tank, and means operated by said float for controlling the current through said solenoid and thereby alternately connecting said sewage tank with said compressed air reservoir and the outer air.



PNEUMATIC PATENTS MARCH 11.

MARCH 25.

1,056,782. WHISTLE. HORACE ELLISON, Lynn, Mass.

1,056,789. APPARATUS FOR PRODUCING OZONE. SIEGFRIED HELD, Chicago, Ill.

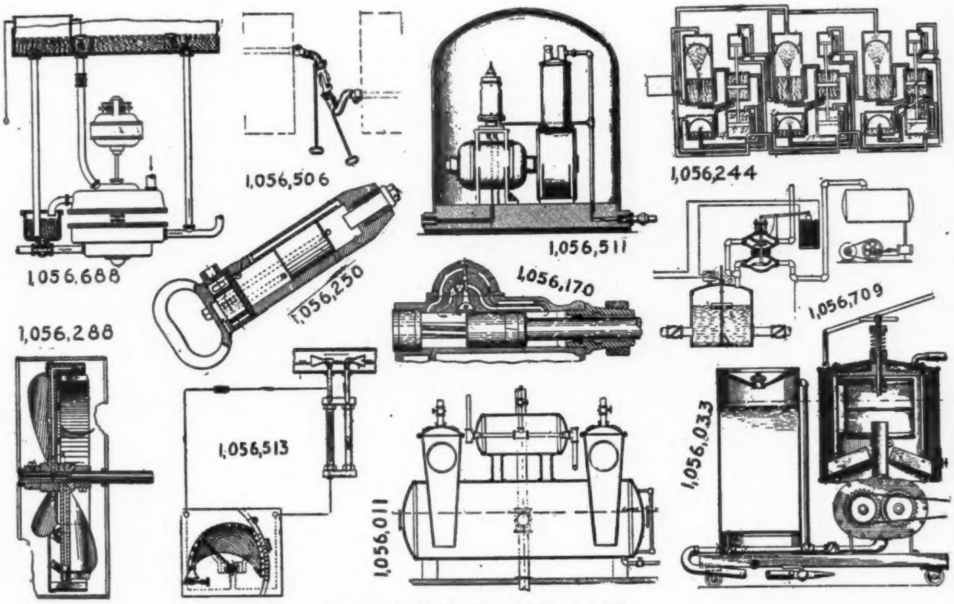
1,056,813. FAN-BLOWER. EMBURY MCLEAN, New York, N. Y.

1,056,859. COMPRESSION AND SUCTION MACHINE. JAMES B. VERNON, Pittsburgh, Pa.

1,056,865. SUCTION-PRODUCING APPARATUS. GEORGE WEBSTER, Christiana, Pa.

1,056,929. AMUSEMENT DEVICE. LEON DE VARGAS NAVARRO, Los Angeles, Cal.

1,056,971. METHOD OF MAKING VACUUM-JACKETED VESSELS. CLYDE J. COLEMAN, New York, N. Y.



PNEUMATIC PATENTS MARCH 18.

1,057,044. PNEUMATIC ANTISLIP DEVICE FOR POWER-DRIVEN VEHICLES. BENJAMIN DOUGLASS, JR., Orange, N. J.

1,057,052. PROCESS OF RECOVERING NITROUS VAPORS OR OXIDS OF NITROGEN DILUTED IN INDIFFERENT GASES. PHILIPPE AUGUSTE GUYE, Geneva Switzerland.

1,057,089. VALVE MECHANISM FOR FLUID-COMPRESSORS. WILLIAM PRELLWITZ, Easton, Pa.

1,057,135. AIR-COMPRESSOR. WILLIAM S. FAIRHURST, New York, N. Y.

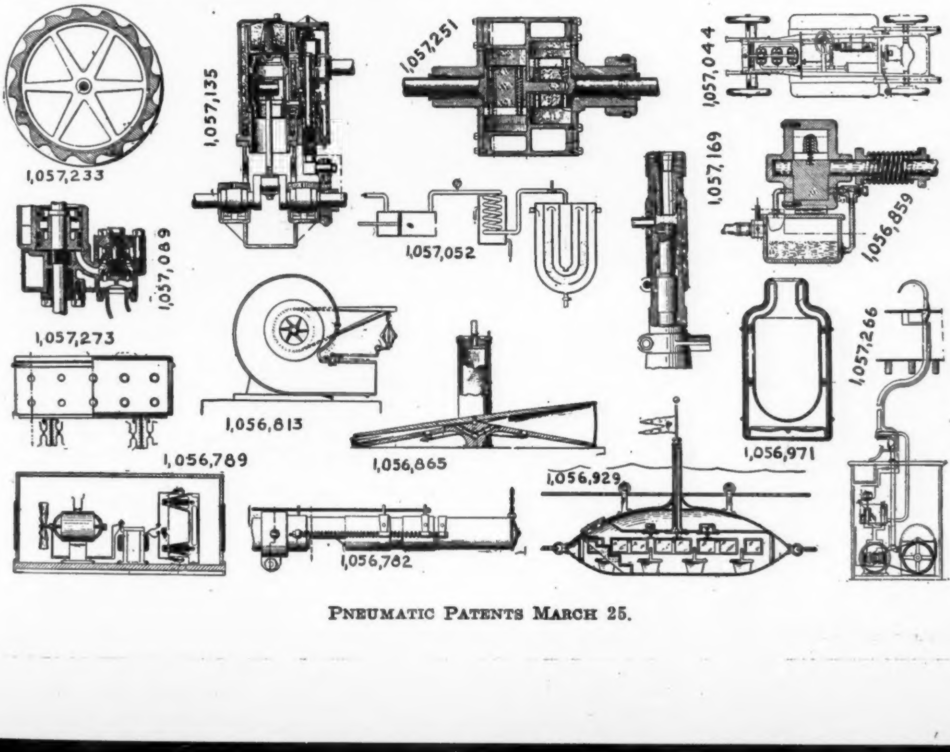
1,057,169. HAMMER-DRILL. WILLIAM PRELLWITZ, Easton, Pa.

1,057,233. FLUID-PRESSURE MOTOR. ANTOINE DE GEOFROY, Paris, France.

1,057,251. FLUID-CONTROLLED CLUTCH. HOWARD I. MANLEY, Kansas City, Mo.

1,057,266. PNEUMATIC-DESPATCH-TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,057,273. AIR-HUMIDOR. JAMES W. RAHN, Temple, Pa.



PNEUMATIC PATENTS MARCH 25.